RV Poseidon Cruise P413

Ligurian Sea/Gulf of Genoa

Cruise Report

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Fig. 1-1. Scientific participants of Poseidon cruise P413.

2. Scientific Background and Goals

Exploring last Glacial and Holocene climate fluctuations represents a major prerequisite for understanding natural climate variability and its impact on human history, as well as for the development of reliable prognostic climate models. Various analyses of instrumental climate data have highlighted the significance of oscillatory modes such as the El Nino/Southern Oscillation (ENSO) and the Arctic Oscillation/North Atlantic Oscillation (AO/NAO). For the Northern Hemisphere, AO/NAO is clearly the dominant mode of winter atmospheric variability at interannual to interdecadal timescales and exerts a strong influence on mid- and high-latitude continental climate (e.g., Thompson and Wallace 2001).

Comparatively little is known about the behaviour of these climate modes on multi-decadal to centennial time-scales, yet this is exactly the behaviour that is most critical to predictions of climate change for the recent century. New Holocene records from the Black Sea and Red Sea (Lamy et al. 2006) show for example pronounced and coherent multicentennial variations with patterns that strongly resemble modern temperature and rainfall anomalies related to AO/NAO. This suggests a prominent role of AO/NAO-like atmospheric variability beyond interannual to interdecadal timescales. Other records from the North Atlantic realm show that substantial AO/NAO variability may also occur on millennial time-scales (Noren et al. 2002). On the other hand, a comparison of drift-ice variations with temperature changes in Europe, Greenland, and the subtropical North Atlantic suggests basin-wide uniform changes on multicentennial to millennial timescales distinct from the modern AO/NAO anomaly pattern (Bond et al. 2001). Thus, more research is needed for a more comprehensive understanding of long-term AO/NAO variability, particularly because on such time-scales, ocean-atmosphere feedbacks that are undetectable in our short instrumental records may become important.

The Mediterranean is a particularly sensitive region for analysing the impact of AO/NAO with clear correlations in the instrumental record that have been extended back in time through combining natural proxy and documentary evidence covering the last ca. 500 years (Luterbacher et al. 2006). There is a significant negative correlation between the winter NAO and rainfall in the southwestern Mediterranean area, as cyclones pass more frequently on a southern track towards the Mediterranean (e.g., Xoplaki et al. 2004). The connection between Mediterranean temperature and the AO/NAO index reveals on the other hand a more complex spatial pattern with a different sign in the western, central, and eastern Mediterranean (e.g., Cullen and deMenocal 2000; Xoplaki 2002).

Within the present project, we plan to focus on paleorecords from the Ligurian Sea, in particular the Gulf of Genoa. This area contains a large potential for studying past rainfall variability as it is one of the four major Mediterranean centres for cyclogenesis (e.g., Trigo et al. 1999). The cyclones constitute the major source for rainfall in the Mediterranean and a better understanding of their long-term behaviour is thus of invaluable socio-economic significance (Wigley 1992). Though not directly related to AO/NAO-controlled shifts in the track of Atlantic depressions, cyclogenesis in the Gulf of Genoa is likewise largely influenced by changes in this climatic mode and has a large impact on rainfall variability in northern Italy and the Southern Alps. The strongest depressions form when cold arctic/subarctic air outbreaks (that are more frequent during negative AO/NAO) flow through the Rhone valley into the Gulf of Lions and the Ligurian Sea during late autumn when sea surface temperatures are still comparatively high (Russo and Sacchini 1994).

The past behaviour of cyclogenesis in the NW Mediterranean is not well known. There are some indications that severe floods in Italy and southern France, related to cyclones in the NW Mediterranean Sea, were more frequent during the coldest intervals of the Little Ice Age (Grove 2001; Giraudi 2005), when arctic/subarctic air outbreaks were likely more common. Instrumental data from Italy covering the past ca. 120 years suggest that total rainfall generally decreased. However, the intensity of individual rainfall events increased, particularly in the northern part of the country (Brunetti et al. 2004). Precipitation reconstructions beyond the past few centuries (see review by Luterbacher et al. 2006) are rare. As in the eastern Mediterranean (e.g., Arz et al. 2003), conditions in the NW

Mediterranean during the early Holocene seem to have been likely more humid than present. These findings were derived from both lake records in central Italy and marine records from the Adriatic Sea (e.g., Ariztegui et al. 2000; Chondrogianni et al. 2004). Glacial records from the Alboran Sea in the westernmost Mediterranean suggest that aridity during the coldest phases (in particular during North Atlantic Heinrich events) was enhanced possibly connected with extended and more stable high-pressure conditions. This has been interpreted in terms of prevailing positive AO/NAO conditions (Combourieu Nebout et al. 2002). Outside the Alboran Sea, there are only very few long marine records (e.g. from the Balearic Margin (Sierro et al. 2005), Tyrrhenian Sea (Kallel et al. 1997; Sbaffi et al. 2004; Carboni et al. 2005), and the central Adriatic (Asioli et al. 2001; Sangiorgi et al. 2003)) with millennial to centennial-scale resolution. These records show for instance cold spells during the well-known North Atlantic cold phases of Termination 1 and likewise significant paleosalinity changes.

The major goal of Poseidon cruise P413 was to collect gravity cores from the Ligurian Sea in order to obtain continuous paleoenvironmental records of adequate resolution and length covering the complete Holocene and the later part of the last glacial. To our knowledge there is only one longer sediment records available from this region (Testa et al., 1990). We expect that these new records will provide important information on Holocene and last glacial changes in continental rainfall and surface ocean conditions and will allow to establish relationships to regional oceanographic changes as well as to large-scale atmospheric variability such as the AO/NAO. Due to the mountainous hinterland with very high precipitation, sedimentation rates are expected to be high enough to extract centennial to millennial-scale changes or possibly even decadal-scale. At selected nearshore locations, we expected to recover very high resolution Holocene sediment archives that may also provide records of catastrophic flooding events in the region that frequently cause substantial damage in the region.

A further goal was to collect suitable material for planktic foraminiferal faunal and genetic analyses along a W-E cross section of the Gulf of Genoa.

3. Cruise Narrative

R/V Poseidon left the port of Messina (Sicily) in the morning of May, 9th, 2011. Scientific crew members mostly arrived already in the morning. As the loading of our containers has been kindly already completed by the crew the day before, we could immediately start with the installation of the scientific equipment already during the harbor day. During the night, a technical revision of one of the ship´s engines has been performed by a German technician that left the ship again in Messina in the early morning of May, 10th, 2011. Thereafter, our 2.5 days transit to the first working area in Strait of Corsica started. After some clouds and swell during the day, weather improved and we arrived with sunny sky and only slight wind on May, 12th, 2011 at ca. 11 a.m. in working area 1 located between the islands of Corsica and Elba. Here we collected sediment cores at three stations (P413/1 to P413/3) where cold water corals were known from previous studies. Two attempts to retrieve a short (3m) gravity core at the first station were unfortunately not successful and we already lost the first core barrel at this site. At the second station, we were more successful and a short core containing corals could be retrieved. After another bent core barrel at the third station, we decided to ship to the next working area after a first CTD cast and the deployment of the multi-net.

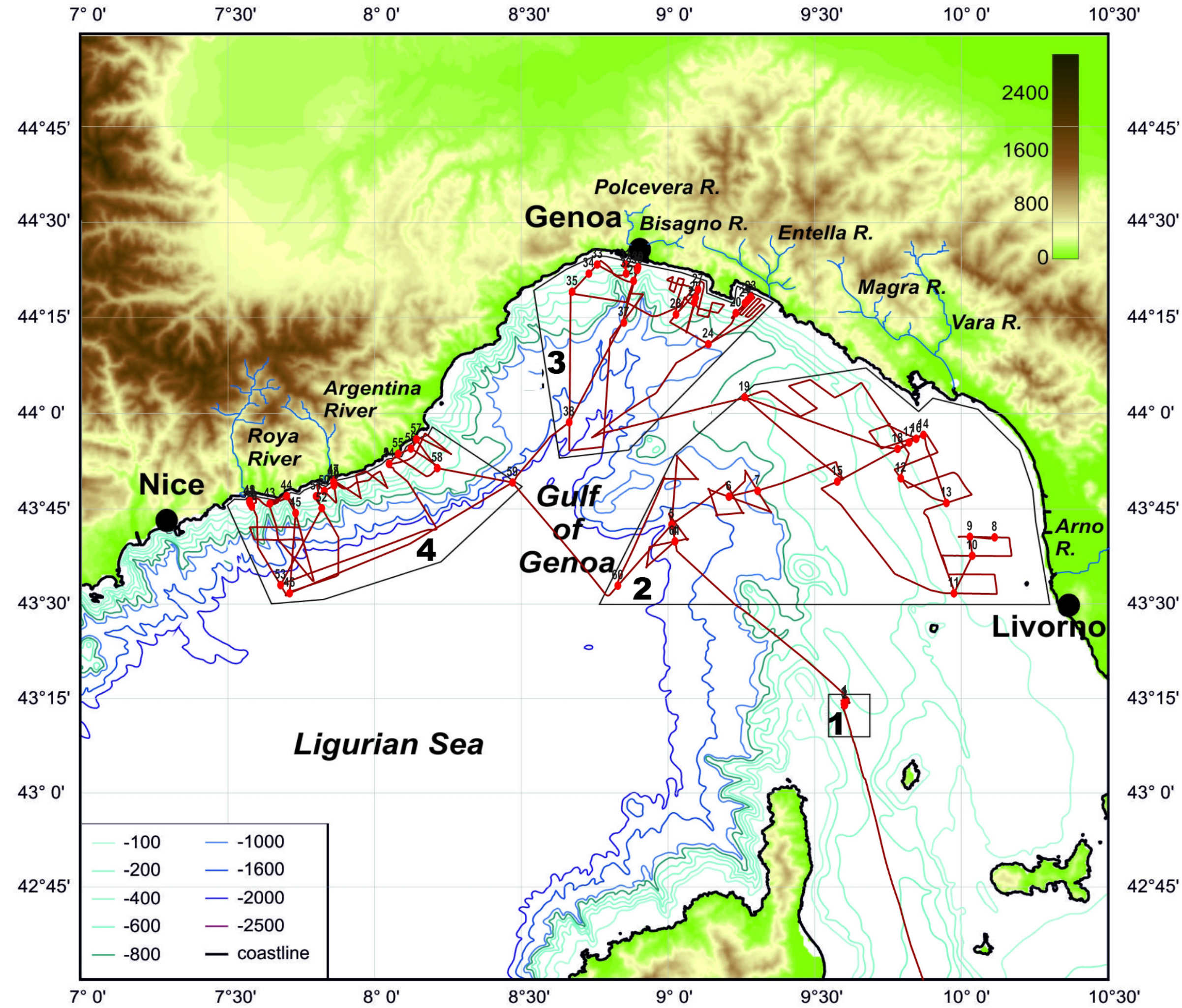

Fig. 3-1: Working areas, ship track, and stations.

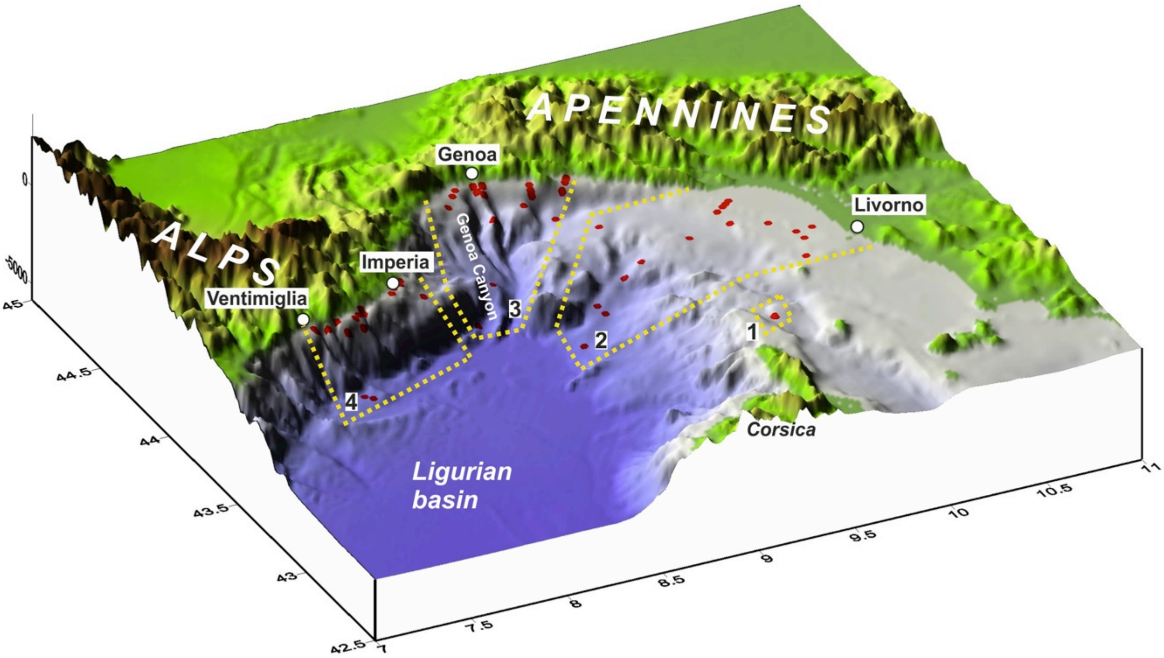

Fig. 3-2: 3-D view of the Gulf of Genoa with stations (red dots) in the different working areas.

Working area 2, located in the eastern Ligurian Sea, was reached at 1 a.m. on May, 13th, 2011. After 5 hours of site survey with the sediment echosounder system, a first deep station (P413/4; 1860 m water depth) at the lower continental slope was sampled with gravity corer (6 and 12 m barrel length) and multi- corer. All deployments were very successful and a maximum core length of 830 cm could be reached. Close to this station we also deployed the CTD and multi-net (station P413/5). The remaining part of the 13th and the following May, 14th were used to retrieve sediment cores and surface sediments (multi-corer) from two more stations (P413/6 and P413/7) upslope at water depths of ca. 1300 m and 750 m after nightly site survey. Core length of the two gravity cores was around 7 m. At the last station, we additionally deployed the CTD and multi-net.

Perfect weather conditions remained until the end of the cruise except for the fast passage of a cold front on May 15th, 2011 that ,however, did not affect our work significantly. From May, 15th to May to May, 17th, 2011 we primarily worked in shallow water depths on the continental shelf between off Livorno and La Spezia. Our nightly echosounder profiles suggested a continuous and thick sediment cover in this area. Therefore, we obtained a detailed sediment core depth transect reaching water depths as shallow as 30 m. In total 11 stations (P413/8 to P413/18) were sampled on the shelf with gravity core lengths mostly between 400 and 600 cm. At these shallow water depths we refrained from deploying the multi-corer in order to save time for changing the heavy coring devices and instead used the so-called Frahmcorer, designed at the IOW Warnemünde, that can be deployed with a small winch. This device can retrieve only one core reaching a maximum length of 80 cm. At shallow water depths it can be run several times as each deployment only takes a few minutes and the changing of tube is very fast. During the short transit to working area 3, a ca. 700 cm long gravity core and multi-cores were retrieved from the mid-slope at a water depth of ca. 700 m (station P413/19) where also the multi-net was deployed.

Station work in area 3 (central Gulf of Genoa) started in the early morning of May 18th, 2011 after a first echosounder site survey during the previous night. A depth transect (P413/20 to P413/24) from the shelf area of the Gulf of Tigullio southeast of the Portofino promontory to the adjacent mid-slope at a water depth of ca. 900 m was sampled during the 18th May, 2011. Gravity core lengths ranged from 250 to 500 cm on the shelf and up to ca. 800 cm on the slope. In parallel, we again deployed the Frahmcorer in shallow water depths and the multicorer on the continental slope. A CTD cast and multi-net deployment were performed at the deepest site. During the following day (May, 19th, 2011), we worked on a similar depth transect northeast of the promontory where thick Holocene sediments accumulate. Coring at this transect (stations P413/25 to P413/28) was again very successful. On the evening of May 18th, 2011 the “hump day” party reminded us that half of the cruise had already passed. With “fresh energy” and site survey during the night, we proceeded our work on the next day (May, 20th, 2011) on the shelf directly offshore Genoa where a number of gravity and Frahm cores were retrieved (stations P413/29 to stations P413/32). On May, 21st, 2011 we took some additional cores from the shelf slightly to the west (off Voltri and Arenzano; stations P413/33 to P413/36). On the same day we headed southward to a station at ca. 750 m water depth located on a ridge between two canyons (station P413/37 with gravity and multi cores as well as CTD and multi-net). On our way to the final westernmost working area we additionally sampled one station at the lower continental slope (station P413/38) where a 650 cm long gravity core was retrieved.

We arrived in working area 4 in the western Ligurian Sea between off Imperia and Ventimiglia on May, 22nd, 2011. Within this area we started close to the French border again on the shelf where our echosounder survey revealed only patchy sediment cover mostly off the mouths of local rivers. In these “mud lenses” we could mostly recover sediment cores with lengths between 250 and 520 cm at 4 stations (P413/39 to P413/42) as well as short Frahm cores. We proceeded the shelf work (stations P413/43 and P413/44) on the next day (May 23rd, 2011) westward and down the very steep and incised continental slope where we retrieved a ca. 500 cm long sediment core at a water depth of ca. 300 m on a small plateau (station P413/45). Thereafter, we steamed offshore in order to find a deep station close to the base of the continental slope at a water depth of 2200 m (station P413/46). At this station we further deployed the multi-corer, multi-net, and CTD. After intensive site-survey during the night, we proceeded on the following day (May, 24th, 2011) with work on the shelf off Imperia (stations P413/47 to P413/51 with gravity and Frahm corer) and steamed again offshore for another intermediate water depth station at a depth of ca. 400 m (station P413/52). The work during this day finished with a deep station at the base of the slope on a slightly elevated position in order to obtain an undisturbed sediment record. A more than 700 cm long gravity core was recovered here (station P413/53). On May 25th, 2011, we finished our work on the shelf with four more shallow stations sampled with gravity and Frahm corer (stations P413/54 to P413/57) and a further intermediate depth station at ca. 500 m water depth (station P413/58) where two gravity cores with 6 and 12 m barrel length were recovered (500 and 530 cm long) as well as the multi-corer was deployed. From there, we proceeded offshore in order to find a further deep station at the base of the continental slope, where we deployed the CTD and two times the multi-net (station P413/59). Further echosounder work during the night revealed two suitable stations for sediment coring which we accomplished until the early afternoon of May, 26th, 2011. At two stations (stations P413/60 and P413/61) at water depths of 2250 and 2000 m, we recovered the last two gravity cores with lengths of ca. 600 and 430 cm.

After this final station, we started our transit to Genoa, where we arrived in the early morning of May, 27th, 2011. During the transit, the scientists started to uninstall our equipment and pack the containers. This work was finished during the harbour day in the evening. Poseidon cruise P413 ended with our disembarkment in the morning of May 28th, 2011. Considering the comparatively short length of our cruise and the small number of crew members and scientists, we were very successful. In total, we steamed ca. 1800 nm including about 785 nm of nightly site survey with the sediment echosounder. CTD and multi-net were deployed 8 and 15 times, respectively. 119 deployments of the Frahm corer recovered 44 m of sediment. The multi-corer was deployed 13 times at intermediate and deep water depths. Finally, 265 m of sediment cores where recovered with the gravity corer with maximum lengths of more than 800 cm. This work was only possible due to the very collaborative captain and crew of R/V Poseidon and, of course, the hard work of the scientific party.

4. Operations and preliminary results

4.1. CTD-Profiling and Rosette *(N. Ruggieri, O. Dellwig, G. Nickel)*

Vertical water column profiles of temperature, conductivity (salinity) and oxygen were obtained by using a CTD (SeaBird SBE 911 plus) equipped with an ECO fluorometer to measure fluorescence (reflecting chlorophyll-a concentrations). Water samples were obtained with a carousel system attached to the CTD and equipped with 12 l Niskin bottles (Fig. 4.1-1).

The CTD data, immediately available on the ship, are of use for interpreting the vertical structure of the water column and the local hydrography, and were directly used to determine the sampling depths for the different water column-based projects (chapter 4.2).

During the P413 expedition, the CTD-profiler was deployed at 8 stations along the cruise track (Tab. 4.1-1). We obtained one profile in the Corsica Channel (working area 1, 327 m), two in the continental shelf and one in the continental slope of the Eastern Ligurian Sea (working area 2, 1716, 747 and 431 m), two in the Central Ligurian Sea (working area 3, 852 and 730 m), and two in the Western Ligurian Basin (working area 1, 2194 and 2282 m).

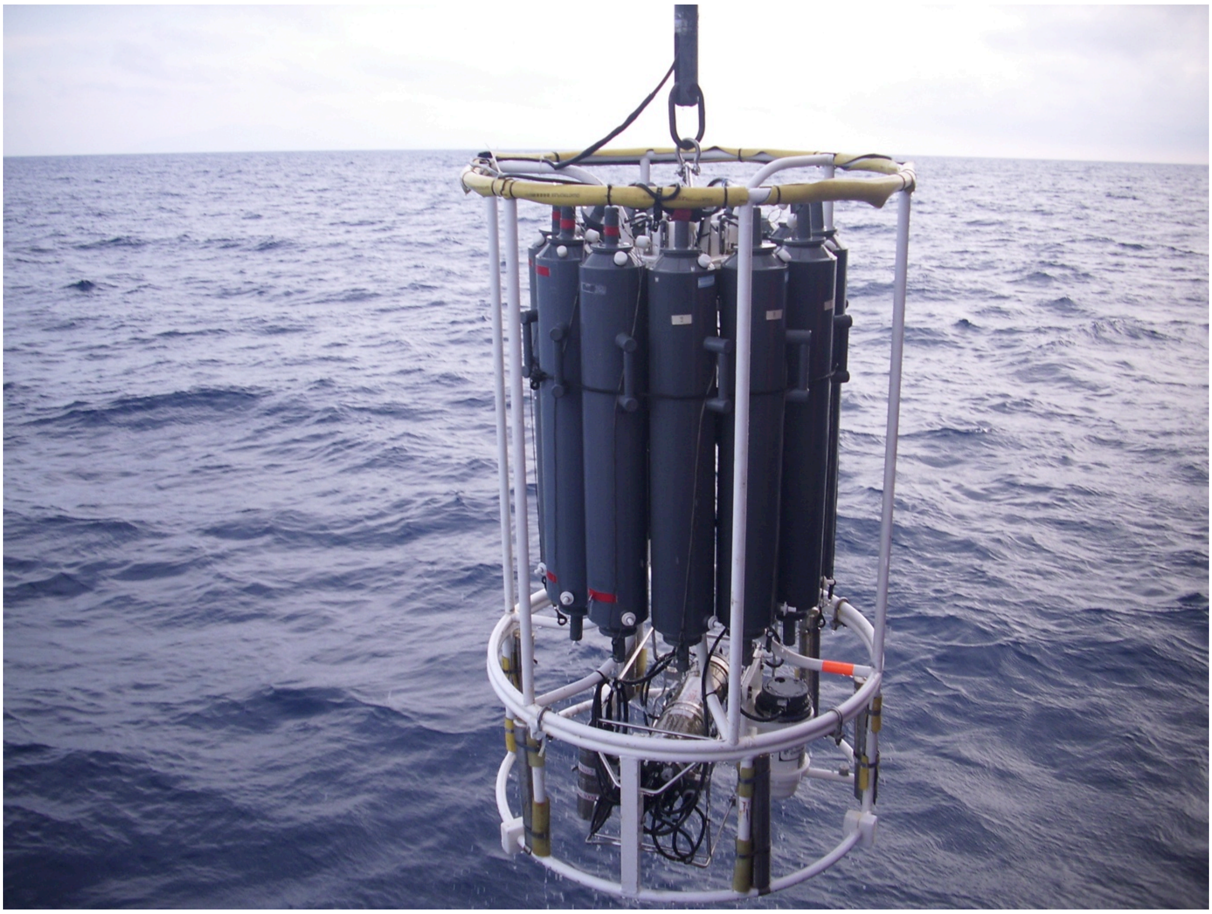

Fig. 4.1-1: Water sampler device (Rosette) equipped with CTD and Fluorometer (photo: M. Bartels).

4.1.1. Preliminary results of hydrographic measurements

The hydrological data set collected during the P413 expedition revealed the principal characteristics of the water masses present in the Ligurian Sea (Fig. 4.1-2). The three major typical water masses of the western Mediterranean Sea were evidenced in the deeper stations. The Modified Atlantic Water (MAW - T and S with seasonally variable characteristics) originates from surface inflows in the Strait of Gibraltar and is recognised as a fresh, buoyant surface layer (0–200 m), which is steadily modified as it flows eastward through mixing and air-sea interactions (Bryden and Stommel, 1984; Send et al., 1999). The Levantine Intermediate Water (LIW - T ~ 13.2 to 13.5 °C, and S ~ 38.5 to 38.6 psu) lies below this layer (400–600 m), it is formed in the Levantine Basin of the Eastern Mediterranean and is recognised by a distinct subsurface salinity maximum in vertical profiles (Rohling and Bryden, 1992). Below the Western Mediterranean Deep Water (WMDW - T ~ 12.75 to 12.90 °C, and S ~38.40 to 38.48 psu) occurs which, following formation by mixing of MAW and LIW during deep convection in the regions, spreads out through the Western Mediterranean basin with a core at ~ 2000 m (La Violette, 1994). The upper part of the WMDW is constituted by mixing of LIW and dense waters from the Tyrrhenian Sea (Millot, 1999; Millot et al., 2006).

Temperature data indicated a vertical gradient within the upper 40-70 m of the water column, corresponding to the onset of seasonal thermal stratification. The surface layer was generally characterized by lower salinity. The chlorophyll maximum was located in all the stations just below the thermocline, with slightly higher concentrations in the Western Ligurian Sea. The oxygen showed the highest values in correspondence or over the chlorophyll maximum. A pronounced oxygen decrease around 400 m has been observed in almost the deeper profiles, extending until 1000 m or more. Together with slightly higher temperature and salinity, it marked the presence of LIW. At water depths >1000 m (1500 m in the central-eastern sector), the relatively lower temperature and salinity signed the boundary between LIW and WMDW.

4.1.2. Water column sampling

In addition to the CTD-probe, the CTD/Rosette device consists of a 12-bottle water collector. Each of the 12 10-liter Niskin bottles of the rosette can be closed separately via the data wire of the winch cable. Before deployment, all the bottles have to be opened; the closing mechanism of each bottle has to be connected with the release-switches of the central controlling device. When triggered via computer command from the board unit, a magnetic switch releases strong rubber bands, which close the selected bottle immediately. When all bottles are closed/filled and the device is back on deck, small vents on top and bottom of each bottle allow for an easy access to the collected water.

Water sampling for stable isotope analyses ($\delta^{18}O$)

Since different water masses can be distinguished by their oxygen isotope signatures ($\delta^{18}O$), this stable isotope ratio is frequently used as tools for reconstructing past changes in deep and surface ocean circulation. In order to extend the modern $\delta^{18}O$ seawater reference dataset, which is essential for the interpretation of paleo-stable isotope records, seawater samples for stable isotope measurements were taken from different water depths at each station along the cruise track. The sampling depths were chosen individually at each station depending on depth-related changes in salinity, oxygen and temperature provided by the CTD probe in order to sample the main surface- intermediate and deep-water masses. The samples were taken from the 10L Niskin bottles of the CTD rosette. Water samples for oxygen isotope analyses ($\delta^{18}O$) were slowly filled into 100 ml glass bottles and stored at a temperature of 4°C.

Water sampling for dissolved and particulate major and trace elements

From the rosette, water samples were taken for determination of dissolved and particulate major and trace elements. For analysis of dissolved compounds (e.g. major ions, phosphate, and silica) the samples were directly taken with syringes, filtered via 0.4 µm SFCA filters, acidified to 1 vol% HNO_3 (suprapure quality), and stored cold until the measurements by ICP-OES. For the investigation of the geochemical composition of suspended particulate matter, 2 L were filtered with 0.4 µm polycarbonate filters. These filters will be decomposed by acid digestion in the home lab and measured by ICP-OES for e.g. Al, Fe, Ca, Mg, K, P, Ba, Mn, and Sr. Furthermore, a second replicate of these filters will be used for mineralogical inspection of particulate matter by SEM-EDX.

Station No.	Gear	Date (UTC)	Start (UTC)	Latitude N (deg/min)	Longitude E (deg/min)	Area	Water depth (m)
P413/3-3	CTD	12.05.11	16:04	43° 14.4339' N	9° 37.3160' E	1	303
P413/5-3	CTD	13.05.11	16:02	43° 43.0039' N	9° 02.1000' E	2	1718
P413/7-4	CTD	14.05.11	13:19	43° 47.7630' N	9° 18.7710' E	2	740
P413/15-3	CTD	16.05.11	15:49	43° 49.5709' N	9° 36.0810' E	2	418
P413/24-2	CTD	18.05.11	16:38	44° 11.0641' N	9° 08.7480' E	3	868
P413/37-2	CTD	21.05.11	09:32	44° 14.5561' N	8° 51.2050' E	3	733
P413/46-4	CTD	23.05.11	17:55	43° 31.8890' N	7° 43.7010' E	4	2210
P413/59-1	CTD	25.05.11	14:16	43° 49.1000' N	8° 28.8020' E	4	2335

Table 4.1-1: CTD stationlist

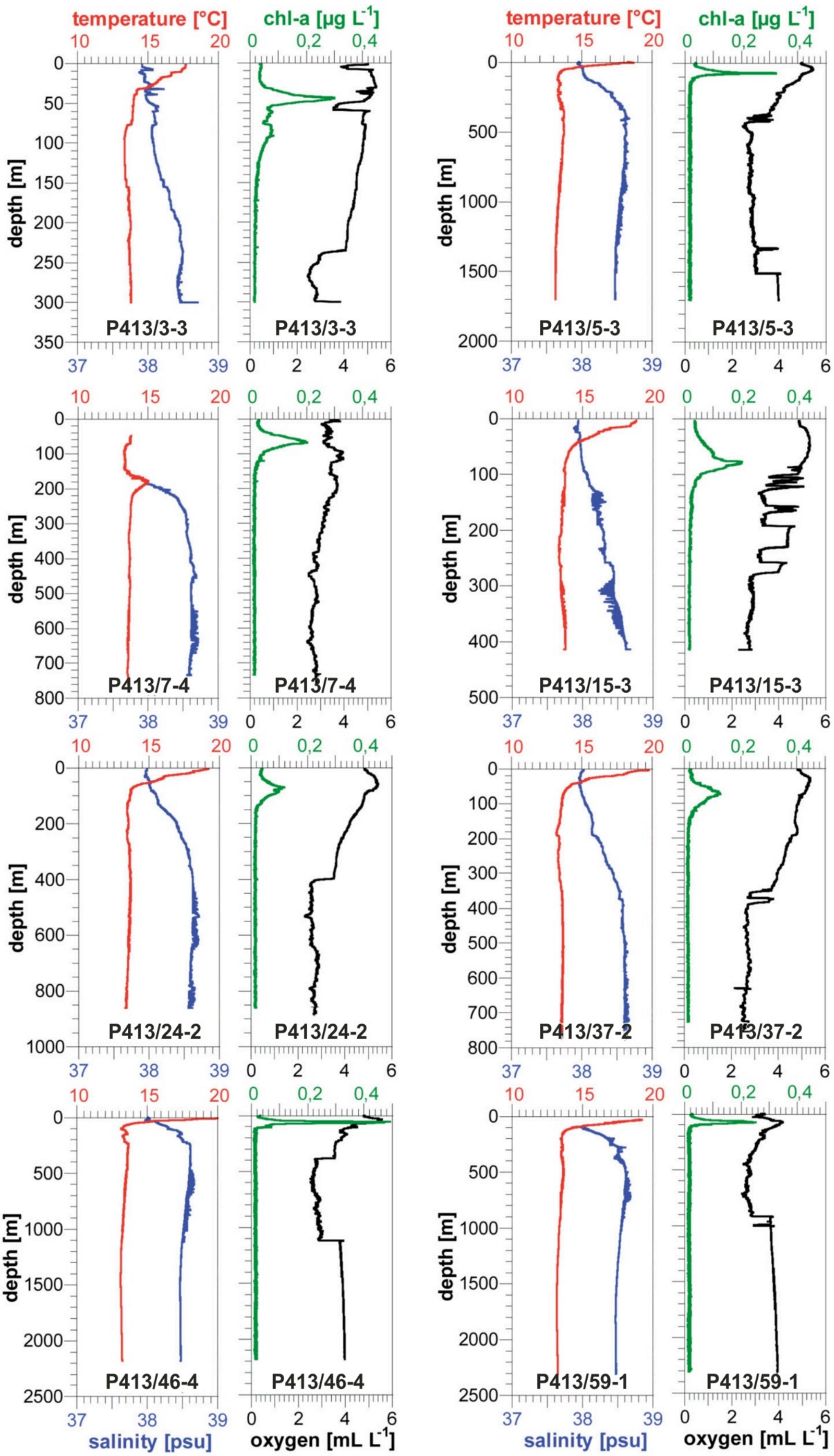

Fig. 4.1-2: Water column profiles.

4.2. Multinet *(Agnes Weiner, Hartmut Schulz)*

Planktonic foraminifera are marine single celled organisms that are found globally in the ocean. So far about 40 different morphospecies are known, that are distinguished using morphological characteristics of their calcite shell. After the death of the cell, the calcite shells sink to the sea floor and are incorporated into the sediment. Genetic investigations of planktonic foraminifera only started fifteen years ago. Since then a systematic analysis of the gene that codes for the RNA of the small ribosomal subunit revealed an unexpectedly high genetic diversity within the known morphologically defined species. The number of genotypes discovered to this date already more than doubles the number of morphospecies. Whereas each morphospecies normally shows a cosmopolitan distribution in the world ocean throughout its preferred temperature province, the genotypes often show more complex distribution patterns. The aim of our research is a screening of different morphospecies, especially those occurring in the Mediterranean Sea, in search for new genotypes and the analysis of their distribution and the processes that lead to their evolution. The samples of planktonic foraminifera taken during the research cruise Poseidon 413 in the Gulf of Genoa will contribute to our already existing dataset containing samples from various areas in the Mediterranean Sea. The uniquely high sampling density in the Mediterranean Sea will allow us to attempt for the first time to estimate the total genetic diversity of planktonic foraminifera in a comprehensive oceanic region.

During the Poseidon 413 cruise, planktonic foraminifera were collected for molecular genetic studies using a multiple closing plankton net (HydroBios, Kiel, 50 x 50 cm opening) with five nets (100 µm mesh size) which allows stratified vertical sampling with five depth intervals. A total of 9 stations were sampled, 7 of these twice (see table 1). The sampling depth was adjusted according to the water depth, resulting in two different sets of depth intervals (100m-80m, 80m-60m, 60m-40m, 40m-20m, 20m-0m and 700m-500m, 500m-300m, 300m-200m, 200m-100m, 100m-0m). Slacking and hoisting was done at 0.5 m/s. After each haul the net bags were washed with sea water and the net cups were rinsed and cleaned with filtered sea water. At 4 stations (net numbers: K253, K254, K256 and K258) a fluorescence probe was attached to the sampler to record the concentration of pigments in the water column. The probe detects the presence of green algae, bluegreen algae, diatoms, cryptophytes, and indifferent yellow substances by in-situ spectral fluorometry. Measurements were done every two seconds for one second resulting in a vertical resolution of about 1 m. Unfortunately the probe did not deliver any useful data due to a so far undetected error.

For the genetic analysis planktonic foraminifera containing cytoplasm were individually picked under the microscope from all sampling intervals. After cleaning with a fine brush the individuals of one depth interval were all placed together on a cardboard slide and frozen at -40°C to facilitate DNA preservation until further processing in the laboratory. The main species found in the Gulf of Genoa were *Globigerina bulloides*, *Orbulina universa* and *Globorotalia truncatulinoides*. The deep intervals were dominated by *G. truncatulinoides* (left coiling variety), whereas on the surface mainly the other two species were found. Few individuals of the species *Hastigerina pelagica*, *Hastigerinella digitata, Globorotalia inflata* and *Neogloboquadrina incompta* were also present. Four nets (K255, K257, K260 and K268, see table 1) were conserved completely in formol, buffered to a pH of ~8.5, without previous extraction of the foraminifera. These samples can be used later on to analyse the assemblage of foraminifera by counting the empty shells.

Fig. 4.2-1: The multiple closing plankton net (photo: Martin Bartels)

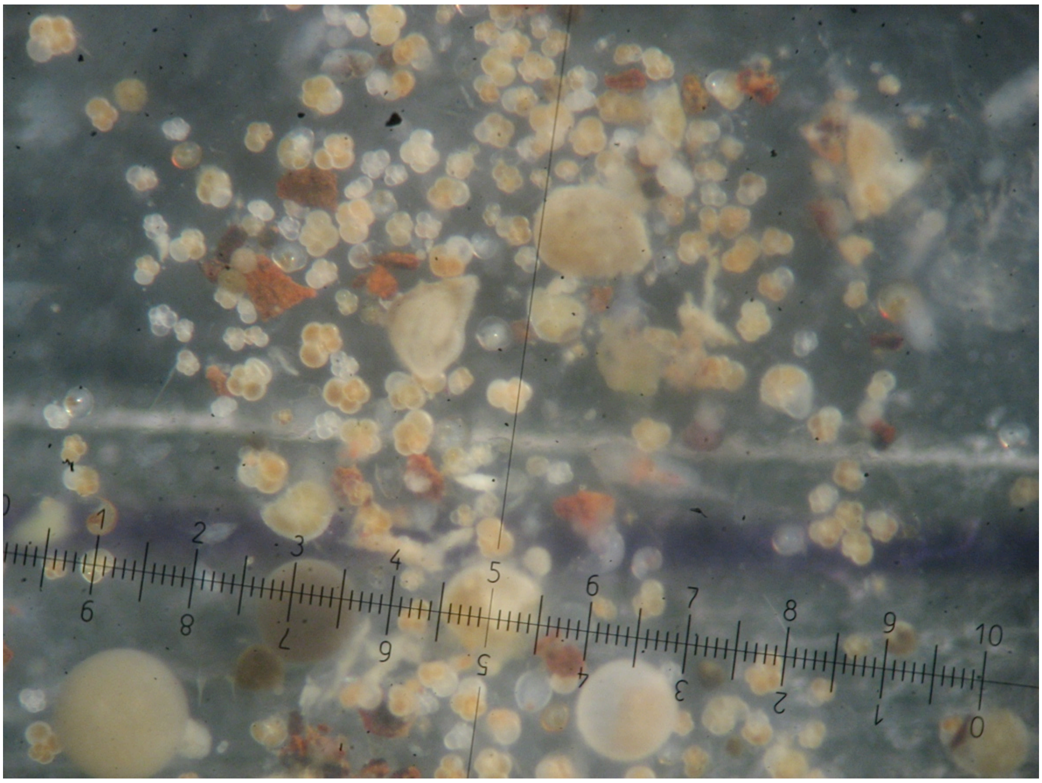

Fig. 4.2-2: Planktonic foraminifera under the binocular microscope (photo: Agnes Weiner)

Sampling	Net number	Date	Cruise station	Latitude	Longitude	Water depth (m)	Net depth (m)	Number of nets	Preparation method
1	K253	12.05.2011	3-2	43° 14.44' N	09° 37.33' E	327	100	5	picked
2	K254	13.05.2011	5-4a	43° 42.99' N	09° 02.10' E	1716.7	700	5	picked
3	K255	13.05.2011	5-4b	43° 42.995' N	09° 02.105' E	1715.6	100	5	conserved
4	K256	14.05.2011	7-3a	43° 47.763' N	09° 18.775' E	746.2	700	5	picked
5	K257	14.05.2011	7-3b	43° 47.761' N	09° 18.793' E	746.6	100	5	conserved
6	K258	16.05.2011	15-4	43° 49.57' N	09° 36.08' E	414.8	100	5	picked
7	K259	17.05.2011	19-3a	44° 02.51' N	09° 15.99' E	661.2	600	5	picked
8	K260	17.05.2011	19-3b	42° 02.52' N	09° 16.02' E	662.5	100	5	conserved
9	K261	18.05.2011	24-4a	44° 10.92' N	09° 08.47' E	863.1	700	5	picked
10	K262	18.05.2011	24-4b	44° 10.95' N	09° 08.52' E	859	100	5	picked
11	K263	21.05.2011	37-3a	44°14.496' N	08°51.204' E	727.8	700	5	picked
12	K264	21.05.2011	37-3b	44°14.503' N	08°51.199' E	728.9	100	5	picked
13	K265	23.05.2011	46-2a	43°31.71' N	07°43.61' E	2195.2	700	5	picked
14	K266	23.05.201	46-2b	43°31.69' N	07°43.61' E	2196.4	100	5	picked
15	K267	25.05.2011	59-2a	43°49.103' N	08°28.814' E	2281.8	700	5	picked
16	K268	25.05.2011	59-2b	43°49.102' N	08°28.788' E	2285.4	100	5	conserved

Tab. 4.2-1: Stations for sampling of planktonic foraminifera using a multiple closing plankton net

4.3. Sediment Echosounding *(G. Nickel, H. Arz)*

A mobile version of the SES-2000-medium Narrow-Beam Parametric Sub-Bottom Profiler (Fig. 4.3-1) developed by Innomar Technology GmbH (www.innomar.com) was provided free of charge from Innomar for sediment acoustic profiling during the RV Poseidon P413 cruise. Sub-bottom profilers are used to picture sub-seafloor geological structures and embedded objects. Therefore the frequencies used for sub-bottom profiling have to penetrate the seafloor and the attenuation in the water and in the sediments should be as low as possible. The SES-2000 medium sub-bottom profiler transmits very narrow sound beams; the half-power width is about ±1.0°. He covers a wide range of transmission frequencies. The centre frequency is adjustable in the range of about 3.5 – 15 kHz, the pulse length can be adjusted in the range of about 66 – 800 µs. The SES 2000 medium covers a depth rage of 5 – 2000 m water depth. The system's on-line operation, data acquisition as well as data replay is managed by the system software, called "SES for Windows" (or SESWIN for short) (from SES 2000 Users Guide, Innomar Technology GmbH).

During RV Poseidon cruise P413 a total profile length of about 785 nm has been mapped with the SES 2000. About one third covered water depths >1000 m from the continental slope of the northern Ligurian Sea and two third concentrated on the shelf areas of the Gulf of Genoa, where we mapped the Holocene sediment deposition centers located proximal to larger rivers entering the gulf and which have been described in detail by Corradi et al. (2004). The complete list of profiles is provided in Table 4.3-1. Three examples are shown in chapter 4.4.

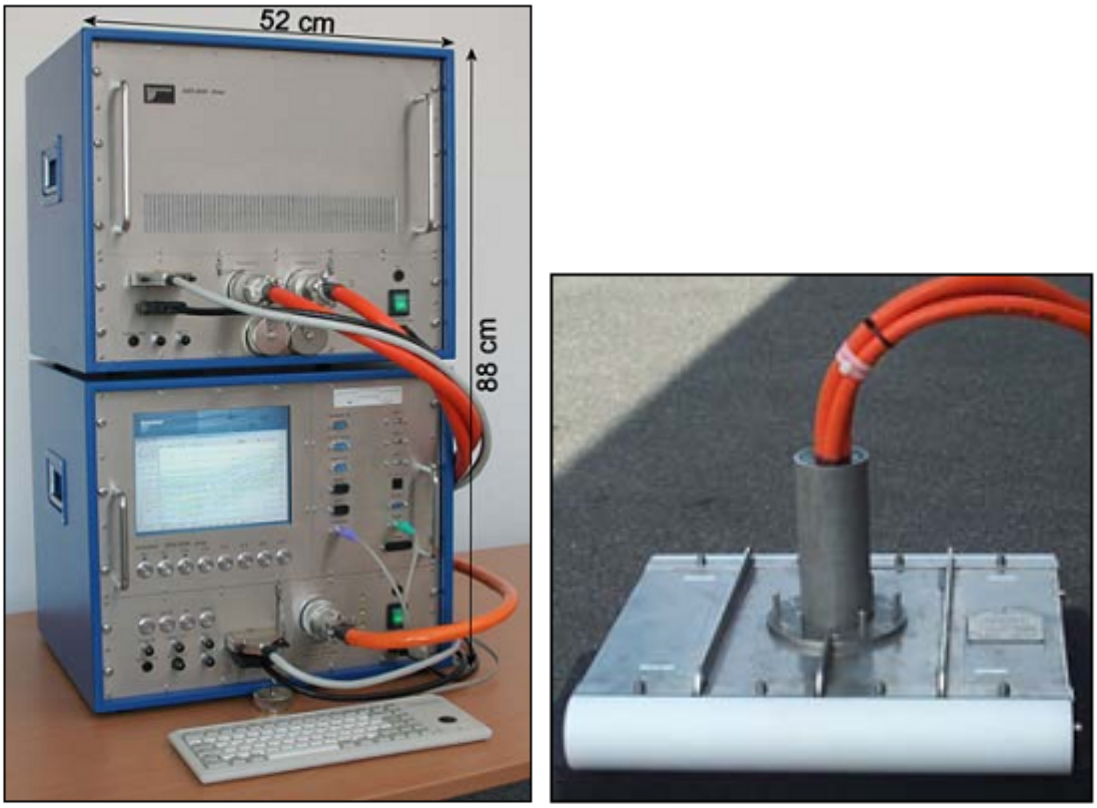

Fig. 4.3-1: The portable parametric sediment echosounder SES-2000-medium, recording and transmitting units (blue boxes); Innomar Technology GmbH, pictures from the User's Guide

Profile No.	Latitude Start	Longitude Start	Latitude End	Longitude End	Profile length (nm)
1	43°13.09	9°36.40	43°14.20	9°36.41	1.1
2	43°14.39	9°36.30	43°13.00	9°36.20	1.4
3	43°13.01	9°36.30	43°14.20	9°36.20	1.2
4	43°14.15	9°36.44	43°14.10	9°36.98	0.4
5	43°14.04	9°36.63	43°13.75	9°34.55	1.5
6	43°13.75	9°36.56	43°14.46	9°35.88	0.9
7	43°30.22	9°13.49	43°38.18	9°02.36	11.3
8	43°38.47	9°02.24	43°43.93	9°00.84	5.6
9	43°43.89	9°00.87	43°40.12	9°04.37	4.5
10	43°40142	9°04.31	43°39.77	9°02.04	1.7
11	43°39.74	9°01.85	43°38.86	8°56.73	3.8
12	43°38.84	8°56.72	43°35.70	8°56.15	3.2
13	43°35.73	8°56.16	43°39.75	9°01.90	5.8
14	43°42.50	9°01.38	43°45.60	9°06.96	5.1
15	43°45.62	9°06.99	43°48.91	9°12.39	5.1
16	43°48.37	9°12.79	43°44.27	9°15.71	4.6
17	43°44.27	9°15.57	43°43.94	9°10,42	3.7
18	43°43.96	9°10.52	43°47.91	9°08,90	4.1
19	43°47.94	9°08.95	43°44.46	9°21.34	9.6
20	43°44.48	9°21.39	43°50.85	9°16.35	7.3
21	43°50.83	9°16.31	43°49.35	9°16.18	1.5
22	43°49.18	9°16.00	43°47.60	9°13.90	2.2
23	43°49.15	9°24.31	43°52.33	9°34.62	8.1
24	43°52.07	9°34.86	43°49.64	9°36.22	2.6
25	43°49.60	9°36.08	43°48.66	9°33.29	2.2
26	43°37.97	9°43.38	43°31.61	9°56.30	11.3
27	43°31.51	9°57.30	43°31.40	10°07,48	7.4
28	43°34.48	10°06.94	43°34.48	9°57.20	7.1
29	43°37.53	9°56.72	43°37.42	10°10.35	9.9
30	43°38.29	10°10.40	43°40.31	10°09.97	2.0
31	43°40.34	10°09.20	43°40.50	10°00.01	6.6
32	43°42.73	9°53.08	43°44.44	9°52.75	1.7
33	43°44.78	9°53.00	43°50.63	9°58.35	7.0
34	43°50.62	9°58.30	43°48.28	9°49.53	6.7
35	43°48.54	9°49.09	43°51.09	9°46.70	3.1
36	43°51.17	9°46.70	43°53.83	9°55.36	6.8
37	43°53.93	9°55.46	43°56.75	9°53.17	3.3
38	43°56.75	9°52.98	43°54.52	9°44.14	6.7
39	43°54.60	9°43.88	43°57.20	9°41.60	3.1
40	43°57.25	9°41.77	43°58.26	9°45.56	2.9
41	43°58.28	9°45.65	43°49.75	9°47.91	8.7
42	43°56.65	9°52.57	43°49.24	9°35.01	14.7
43	43°52.91	9°30.70	44°02.44	9°16.27	14.1
44	44°02.44	9°16.27	44°03.44	9°20.95	3.5
45	44°03.44	9°20.95	43°59.61	9°27.40	6.0

Table 4.3-1: Echosounder profiles mapped during Poseidon Cruise P 413.

Table 4.3-1 (continued)

Profile No.	Latitude Start	Longitude Start	Latitude End	Longitude End	Profile length (nm)
46	43°59.61	9°27.40	44°00.95	9°30.73	2.7
47	44°00.95	9°30.73	44°04.33	9°25.20	5.2
48	44°04.33	9°25.20	44°05.26	9°29.79	3.4
49	44°05.26	9°29.79	44°02.64	9°34.38	4.2
50	44°02.64	9°34.38	44°94.89	9°39.90	92.3
51	44°04.81	9°40.04	44°58.27	9°45.57	53.6
52	44°02.97	8°57.40	44°03.78	8°58.53	1.1
53	44°03.78	8°58.53	44°08.09	9°02.27	5.1
54	44°08.09	9°02.27	44°15.22	9°17.80	13.2
55	44°17.38	9°19.58	44°15.38	9°16,90	2.8
56	44°14.57	9°16.30	44°18.05	9°19.44	4.1
57	44°18.23	9°18.69	44°15.70	9°15.50	3.4
58	44°15.94	9°15.04	44°18.45	9°18.12	3.3
59	44°18.64	9°17.45	44°15.33	9°13.53	4.3
60	44°11.37	9°08.00	44°14.57	9°00.90	6.0
61	44°14.63	9°00.90	44°16.70	9°03.12	2.6
62	44°16.70	9°03.12	44°18.49	9°03.97	1.9
63	44°18.49	9°03.97	44°17.50	9°05.80	1.6
64	44°17.50	9°05.80	44°21.08	9°07.12	3.7
65	44°20.76	9°07.76	44°17.17	9°06.90	3.6
66	44°17.17	9°06.90	44°15.82	9°06.46	1.4
67	44°15.82	9°06.46	44°15.34	9°08.68	1.7
68	44°15.34	9°08.68	44°17.66	9°09.56	2.4
69	44°17.66	9°09.56	44°17.29	9°11.88	1.7
70	44°17.29	9°11.88	44°16.09	9°10.25	1.7
71	44°16.09	9°10.25	44°16.75	9°06.75	2.6
72	44°16.75	9°06.75	44°17.53	9°05.83	1.0
73	44°17.53	9°05.83	44°13.06	9°04.25	4.6
74	44°16.00	9°02.23	44°17.75	9°02.29	1.8
75	44°17.75	9°02.29	44°31.35	9°03.72	13.6
76	44°21.50	9°02.63	44°19.33	9°01.74	2.3
77	44°19.89	9°00.92	44°21.60	9°01.51	1.8
78	44°21.60	9°01.51	44°21.18	9°00.45	0.9
79	44°21.18	9°00.45	44°20.59	9°02.59	1.6
80	44°15.55	8°57.04	44:17.72	8°52.07	4.2
81	44°17.72	8.52.07	44°23.28	8°54.41	5.8
82	44°17.69	8°52.15	44°19.11	8°40.54	8.4
83	44°19.11	8°40.54	44°24.29	8°46.79	6.8
84	44°19.00	8°40.66	43°54.19	8°40.41	24.8
85	43°54.19	8°40.41	43°54.80	8°47.28	5.0
86	43°54.80	8°47.28	44°11.92	8°48.77	17.2
87	44°11.92	8°48.77	44°19.00	8°55.15	8.4
88	43°38.92	8°28.39	43°39.13	8°07.14	15.4
89	43°39.13	8°07.14	43°31.30	7°42.63	19.4
90	43°31.30	7°42.63	43°38.83	7°36.90	8.6
91	43°38.83	7°36.90	43°43.64	7°36.70	4.8
92	43°43.64	7°36.70	43°46.65	7°35.52	3.1

Table 4.3-1 (continued)

Profile No.	Latitude Start	Longitude Start	Latitude End	Longitude End	Profile length (nm)
93	43°46.65	7°35.52	43°45.86	7°36.46	1.0
94	43°45.83	7°36.34	43°45.37	7°39.30	2.2
95	43°46.22	7°39.38	43°45.37	7°39.30	0.9
96	43°45.37	7°39.30	43°42.45	7°40.54	3.1
97	43°42.45	7°40.54	43°39.82	7°41.30	2.7
98	43°39.82	7°41.30	43°33.46	7°48.14	8.1
99	43°33.46	7°48.14	43°40.91	7°45.75	7.6
100	43°42.00	7°44.18	43°42.00	7°35.33	6.4
101	43°42.00	7°35.33	43°40.06	7°36.23	2.0
102	43°40.06	7°36.23	43°40.00	7°46.03	7.1
103	43°40.00	7°46.03	43°46.02	7°43.97	6.2
104	43°46.02	7°43.97	43°47.20	7°42.42	1.6
105	43°47.20	7°42.42	43°46.19	7°39.32	2.5
106	43°34.69	7°53.30	43°41.35	7°52.63	6.7
107	43°41.35	7°52.63	43°45.48	7°49.58	4.7
108	43°45.48	7°49.58	43°46.66	7°48.53	1.4
109	43°46.66	7°48.53	43°48.64	7°49.24	2.0
110	43°48.64	7°49.24	43°45.90	7°52.84	3.8
111	43°45.90	7°52.84	43°49.44	7°52.29	3.6
112	43°49.44	7°52.29	43°46.73	7°57.73	4.8
113	43°46.73	7°57.73	43°50.24	7°56.90	3.6
114	43°50.24	7°56.90	43°50.87	7°58.84	1.5
115	43°50.87	7°58.84	43°48.36	8°03.21	4.0
116	43°48.36	8°03.21	43°50.79	8°01.90	2.6
117	43°41.97	8°13.21	43°49.22	8°07.45	8.4
118	43°49.22	8°07.45	43°51.01	8°04.69	2.7
119	43°51.01	8°04.69	43°52.05	8°03.66	1.3
120	43°52.05	8°03.66	43°53.17	8°05.21	1.6
121	43°53.17	8°05.21	43°51.58	8°13.70	6.3
122	43°51.58	8°13.70	43°54.80	8°08.43	5.0
123	43°54.80	8°08.43	43°55.66	8°09.45	1.1
124	43°55.66	8°09.45	43°53.64	8°16.29	5.3
125	43°53.64	8°16.29	43°56.82	8°11.09	4.9
126	43°56.82	8°11.09	43°52.05	8°03.64	7.2
127	43°34.98	8°44.05	43°31.15	8°48.23	4.9
128	43°31.15	8°48.23	43°42.36	9°01.18	14.6
129	43°42.36	9°01.18	43°53.23	9°02.37	10.9
130	43°53.23	9°02.37	43°49.58	9°06.55	4.7
				Total:	**784.7**

4.4. Sediment Sampling

We retrieved sediment cores and surface sediments with three different coring devices: gravity corer, multi-corer, and Frahm-corer. Technical details on these coring devices and core recovery are found in chapters 4.4.1 to 4.4.3. Gravity cores have not been opened onboard. We provide an overview on the core recovery in the different working areas together with selected sediment echosounding profiles in chapter 4.4.4.

4.4.1 Frahm-corer and Multi-corer *(M. Bartels & U. Kotthoff)*

The Frahm-corer is a coring device (Fig. 4.4-1) developed at the IOW, which allows taking cores of up to 80 cm length and thus mostly provides an overlap with a gravity core. Although the Frahm-corer is only capable of taking one core, it can be run with a small winch due to its low weight. This was of particular importance during cruise P413, since gravity cores and surface cores are usually needed at the same station. As RV Poseidon is only equipped with one crane for heavy coring devices, the use of the gravity corer and multi-corer at the same station requires a time consuming changing of both devices. Thus, the multi-corer was only used at stations deeper than 300 m water depth, whereas the Frahm-corer was driven two to four times at near-coastal stations.

The coring device can be handled by two people plus the winch driver. The rope speed during cruise P413 usually ranged between 0.5 and 0.7 m/s; in some cases (e.g. silty sediments) up to 1.0 m/s are chosen. The preparation of the corer is simple and can be done within two minutes finally resulting in about 10 min required for a complete cast. Depending on sediment composition, cores of ~60 cm lengths could be recovered in most cases. In total, the Frahm-corer was used ~100 times with ~90% successful corings.

Fig. 4.4-1: Left: Frahm-corer device prepared for lowering. Right: Frahm-corer after retrieving a ~70-cm core.

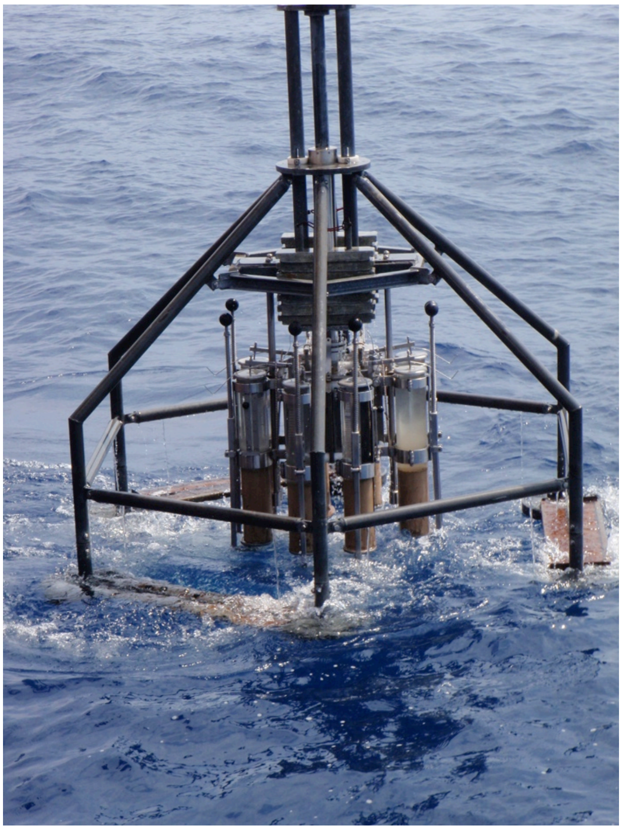

Fig. 4.4-2: The IOW multi-corer after successful deployment with 8 tubes filled.

The IOW multi-corer used during cruise P413 is capable of retrieving eight cores of up to 60 cm lengths with a preserved fluffy surface layer and including the bottom water. The multi-corer was lowered with an average speed of 1 m/s to about ~30-40 m above seafloor, where it was stopped for ~2-3 minutes. It was then lowered with a speed of 1 m/s until bottom contact. Contact with the seafloor was monitored through the cable tension. The multi-corer was left on the seafloor for about 1 minute, then pulled out with a speed of 0.3 m/s and finally heaved with a speed of 1 m/s.

As mentioned above, the multi-corer was only used at stations >300 m water depth (12 casts with one unsuccessful coring). The cores taken with the Frahm- and the multi-corer were sliced in regular intervals of 1 cm and will be analyzed for foraminifera (fauna analyses), biomarkers, bulk parameters (TOC, TIC, TN, TS), clay mineralogy, and major and trace elements. About one third of the cores was archived and will be stored at the Leibniz Institute for Baltic Sea Research in Rostock (Germany).

Apart of one core taken from 1864 m water depth where the first 6 cm were greyish, all other cores had a brownish top-layer subsequently followed by greyish sediments. The thickness of the uppermost brown-coloured sediment layer may correlate with water depth. There is a trend of increasing thickness of the brown-coloured layer with increasing water depth. Most of the cores taken at a water depth less than 100 m had a brown layer of less than 5 cm (~ 44% of the cores in this depth) or of 5 to 10 cm (~ 33% of these cores). Every core taken at 500 to 1000 m depth had a brown layer larger than 10 cm. In addition, these cores and those retrieved at 100 – 500 m water depth were bioturbated, probably resulting in a deeper oxidation, causing the light brownish colours. The brownish layer of the sediment in 100 – 500 m depth varies between less than 5 cm and more than 10 cm, in 1000 – 2000 m it is more than 5 cm thick. Only one core was taken from more than 2000 m depth. This had a brown surface layer of less than 5 cm.

Besides sediment sampling, pore waters are extracted at selected stations by using rhizons (Seeberg-Elverfeldt et al., 2005) immediately after retrieving the cores. The rhizons were connected to syringes (10 mL) through holes in the core liners (Fig. X). Pore waters will be analysed in the home lab for major ions (Na, Ca, Mg, K), trace elements (e.g. Ba, Fe, Mn, Mo, Sr), and the nutrients phosphate and silica by ICP-OES. H_2S and SO_4 will be determined spectrophotometrically. Samples for ICP-OES analyses are acidified to 1 Vol.-% with HNO_3 (suprapure) and for determination of H_2S 2 mL of the sample are fixed in PE reaction tubes containing 100 µl 5% zinc acetate. Pore water data will be used to estimate the impact of present biogeochemical processes on the sedimentary record. Furthermore, we aim to investigate metal and nutrient cycling in surface sediments as well as the release of these components into the overlying bottom waters in different water depths.

Fig. 4.4-3: The use of rhizons for the extraction of pore waters.

Table 4.4-1: Station list for the Frahm-corer with core recovery.

Station No.	Latitude N (deg/min)	Longitude E (deg/min)	Area	Water depth (m)	Core recovery (cm)
P413/8-1	43° 40,392' N	10° 7,074' E	2	32	70
P413/8-3	43° 40,39' N	10° 7,06' E	2	32	70
P413/8-5	43° 40,38' N	10° 7,08' E	2	32	70
P413/8-6	43° 40,396' N	10° 7,06' E	2	32	-
P413/8-7	43° 40,39' N	10° 7,05' E	2	30	70
P413/9-1	43° 40,473' N	10° 2,052' E	2	81	70
P413/9-3	43° 40,47' N	10° 2,04' E	2	79	70
P413/9-4	43° 40,47' N	10° 2,041' E	2	77	70
P413/10-1	43° 37,47' N	10° 02,51' E	2	89	_
P413/10-2	43° 37,47' N	10° 02,52' E	2	86	70
P413/11-2	43° 31,508' N	9° 58,786' E	2	148	70
P413/11-3	43° 31,507' N	9° 58,777' E	2	148	70
P413/12-1	43° 49,8' N	9° 47,999' E	2	213	70
P413/12-2	43° 49,763' N	9° 47,957' E	2	215	70
P413/12-3	43° 49,761' N	9° 47,960' E	2	214	70
P413/12-4	43° 49,757' N	9° 47,967' E	2	214	70
P413/13-1	43° 45,848' N	9° 57,262' E	2	92	70
P413/13-2	43° 45,838' N	9° 57,261' E	2	92	70
P413/14-1	43° 56,654' N	9° 52,578' E	2	36	20
P413/14-2	43° 56,655' N	9° 52,575' E	2	36	20
P413/14-3	43° 56,654' N	9° 52,571' E	2	36	70
P413/16-1	43° 56,029' N	9° 51,094' E	2	59	-
P413/16-2	43° 56,033' N	9° 51,085' E	2	59	-
P413/16-3	43° 56,032' N	9° 51,091' E	2	58	20
P413/18-1	43° 54,442' N	9° 47,315' E	2	116	70
P413/20-1	44° 16,000' N	9° 14,354' E	3	113	70
P413/20-2	44° 16,003' N	9° 14,346' E	3	113	70
P413/21-1	44° 17,573' N	9° 16,202' E	3	69	25
P413/21-2	44° 17,573' N	9° 16,207' E	3	69	20
P413/21-3	44° 17,573' N	9° 16,189' E	3	69	25
P413/22-1	44° 18,084' N	9° 16,799' E	3	52	30
P413/22-2	44° 18,086' N	9° 16,802' E	3	51	55
P413/22-3	44° 18,081' N	9° 16,797' E	3	51	35
P413/23-1	44° 18,585' N	9° 17,406' E	3	26	25
P413/23-2	44° 18,585' N	9° 17,406' E	3	26	25
P413/23-3	44° 18,588' N	9° 17,404' E	3	26	25
P413/23-4	44° 18,587' N	9° 17,403' E	3	26	20
P413/23-5	44° 18,585' N	9° 17,405' E	3	26	10
P413/23-6	44° 18,590' N	9° 17,409' E	3	25	-
P413/23-7	44° 18,588' N	9° 17,409' E	3	26	10
P413/25-1	44° 17,670' N	9° 5,880' E	3	115	40
P413/26-1	44° 18,440' N	9° 6,137' E	3	103	40
P413/27-1	44° 19,726' N	9° 6,629' E	3	77	35
P413/27-2	44° 19,731' N	9° 6,637' E	3	77	25
P413/27-3	44° 19,726' N	9° 6,625' E	3	77	40
P413/29-1	44° 21,097' N	8° 53,501' E	3	106	60
P413/29-2	44°21,089' N	8° 53,497' E	3	106	60

Table 4.4-1 (continued)

Station No.	Latitude N (deg/min)	Longitude E (deg/min)	Area	Water depth (m)	Core recovery (cm)
P413/30-1	44° 23,254' N	8° 54,418' E	3	51	30
P413/30-2	44° 23,265' N?	8° 54,399' E	3	51	55
P413/30-3	44° 23,56' N	8° 54,399' E	3	51	55
P413/30-4	44° 23,257' N	8° 54,403' E	3	51	55
P413/31-1	44° 23,668' N	8° 51,812' E	3	49	-
P413/31-2	44° 23,671' N	8° 51,806' E	3	49	-
P413/31-3	44° 23,664' N	8° 51,807' E	3	49	1
P413/32-1	44° 22,257' N	8° 51,979' E	3	94	60
P413/33-1	44° 23,692' N	8° 46,091' E	3	68	-
P413/33-2	44° 23,692' N	8° 46,101' E	3	68	50
P413/33-3	44° 23,694' N	8° 46,106' E	3	68	50
P413/33-4	44° 23,698' N	8° 46,084' E	3	68	50
P413/33-5	44° 23,697' N	8° 46,078' E	3	68	50
P413/34-1	44° 22,243' N	8° 44,360' E	3	88	60
P413/34-2	44° 22,254' N	8° 44,361' E	3	88	60
P413/35-2	44° 19,382' N	8° 40,959' E	3	196	60
P413/35-3	44° 19,383' N	8° 40,959' E	3	196	60
P413/35-4	44° 19,35' N	8° 40,95' E	3	195	60
P413/36-1	44° 22,845' N	8° 54,245' E	3	67	30
P413/36-2	44° 22,833' N	8° 54,243' E	3	68	30
P413/36-3	44° 22,835' N	8° 54,245' E	3	68	-
P413/36-4	44° 22,839' N	8° 54,250' E	3	68	75
P413/36-5	44° 22,841' N	8° 54,251' E	3	67	75
P413/36-6	44° 22,843' N	8° 54,241' E	3	67	-
P413/39-1	43° 45,273' N	7° 35,681' E	4	71.3	60
P413/39-2	43° 45,290' N	7° 35,696' E	4	71	60
P413/39-3	43° 45,289' N	7° 35,709' E	4	71	60
P413/40-1	43° 45,684' N	7° 35,352' E	4	62	50
P413/40-2	43° 45,685' N	7° 35,358' E	4	62	50
P413/41-1	43° 46,025' N	7° 35,163' E	4	51	-
P413/41-2	43° 46,026' N	7° 35,174' E	4	51	25
P413/41-3	43° 46,019' N	7° 35,176' E	4	51	30
P413/41-4	43° 46,019' N	7° 35,181' E	4	51	25
P413/42-1	43° 46,175' N	7° 35,241' E	4	47	60
P413/42-2	43° 46,167' N	7° 35,245' E	4	47	60
P413/42-3	43° 46,173' N	7° 35,238' E	4	47	60
P413/43-1	43° 45,735' N	7° 39,346' E	4	92	40
P413/43-2	43° 45,734' N	7° 39,333' E	4	92	40
P413/43-3	43° 45,742' N	7° 39,339' E	4	92	40
P413/44-1	43° 46,963' N	7° 42,788' E	4	63	20
P413/44-2	43° 47,002' N	7° 42,798' E	4	63	25
P413/44-3	43° 46,992' N	7° 42,775' E	4	62	25
P413/45-1	43° 44,232' N	7° 44,592' E	4	284	60
P413/45-2	43° 44,243' N	7° 44,585' E	4	284	70
P413/45-3	43° 44,239' N	7° 44,399' E	4	284	70
P413/47-1	43° 49,464' N	7° 52,338' E	4	30	65
P413/47-2	43° 49,466' N	7° 52,342' E	4	30	65
P413/47-3	43° 49,460' N	7° 52,342' E	4	30	65

Table 4.4-1 (continued)

Station No.	Latitude N (deg/min)	Longitude E (deg/min)	Area	Water depth (m)	Core recovery (cm)
P413/48-1	43° 49,119' N	7° 52,350' E	4	56	50
P413/48-2	43° 49,121' N	7° 52,354' E	4	56	50
P413/48-3	43° 49,122' N	7° 52,340' E	4	57	50
P413/49-1	43° 48,619' N	7° 52,433' E	4	93	60
P413/49-2	43° 48,629' N	7° 52,419' E	4	93	60
P413/49-3	43° 48,632' N	7° 52,421' E	4	93	60
P413/50-1	43° 47,757' N	7° 50,449' E	4	89	60
P413/51-1	43° 46,927' N	7° 48,792' E	4	88	40
P413/54-1	43° 52,050' N	8° 3,640' E	4	49	35
P413/54-2	43° 52,052' N	8° 3,644' E	4	49	-
P413/54-3	43° 52,051' N	8° 3,652' E	4	49	-
P413/54-4	43° 52,044' N	8° 3,652' E	4	49	35
P413/54-5	43° 52,046' N	8° 3,651' E	4	49	30
P413/55-1	43° 53,656' N	8° 5,507' E	4	34.9	-
P413/55-2	43° 53,655' N	8° 5,505' E	4	34.8	-
P413/55-3	43° 53,656' N	8° 5,503' E	4	34.8	10
P413/55-4	43° 53,654' N	8° 5,500' E	4	34.8	-
P413/55-5	43° 53,653' N	8° 5,497' E	4	34.8	-
P413/56-1	43° 54,489' N	8° 8,118' E	4	48	-
P413/56-2	43° 54,480' N	8° 8,101' E	4	48	-
P413/56-3	43° 54,477' N	8° 8,103' E	4	48	-
P413/57-1	43° 55,956' N	8° 9,221' E	4	37	-
P413/57-2	43° 55,956' N	8° 9,226' E	4	37	10
P413/57-3	43° 55,955' N	8° 9,220' E	4	37	10
					47.16 m

Table 4.4-2: Station list for the Multi-corer with core recovery.

Station No.	Latitude N (deg/min)	Longitude E (deg/min)	Area	Water depth (m)	Core recovery (cm)
P413/4-3	43° 39,75' N	9° 1,91' E	2	1860,2	25
P413/5-1	43° 42,43' N	9° 1,24' E	2	1737	28
P413/6-2	43° 46,84' N	9° 12,92' E	2	1288	26
P413/7-1	43° 47,76' N	9° 18,75' E	2	750	28
P413/15-2	43° 49,247' N	9° 35, 020' E	2	431	43
P413/19-2	43° 2,628' N	9° 16,117' E	2	657	-
P413/19-3	43° 2,630' N	9° 16,122' E	2	657	39
P413/24-3	44° 11,063' N	9° 8,739' E	3	852	41
P413/37-4	44° 14,506' N	8° 51,210' E	3	735.3	42
P413/38-1	43° 58,665' N	8° 40,427' E	3	1700	35
P413/46-3	43° 31,701	7° 43,595' E	4	2194	29
P413/58-3	43° 51,363' N	8° 13,476' E	4	510	40
P413/60-1	43° 32,718' N	8° 50,271' E	2	2240	28

4.4.2 Gravity corer *(H. Arz, J. Kaiser, S. Plewe)*

During RV Poseidon expedition P413, we deployed the gravity corer (GC) 66 times using barrel lengths between 3 and 12 m (Fig. 4.4-1). The coring frame ("Kernabsatzgestell") was kindly provided by the IFM-GEOMAR Kiel. 59 successful deployments resulted in a total core recovery of ca. 267 m. The length of the coring devices were chosen based on sediment acoustic profiles with the Innomar echosounding system considering acoustic patterns such as the strength of characteristic reflectors, their spacing, and the total sub-bottom penetration (Chapter 4.3). At several locations at shallow water depths, we first deployed a gravity corer with a plastic hose ("Schlauchkern") instead of PVC-liners. On deck, the sediment was squeezed out in order to obtain a fast overview of the sediment (Fig. 4.4-5).

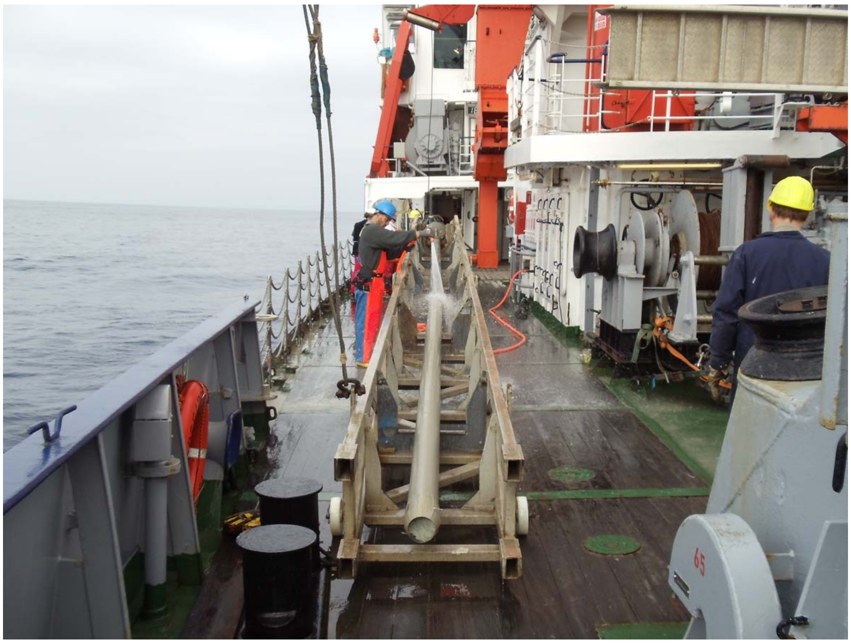

Fig. 4.4-4: Gravity cores with 12 m barrel length at station P413/4.

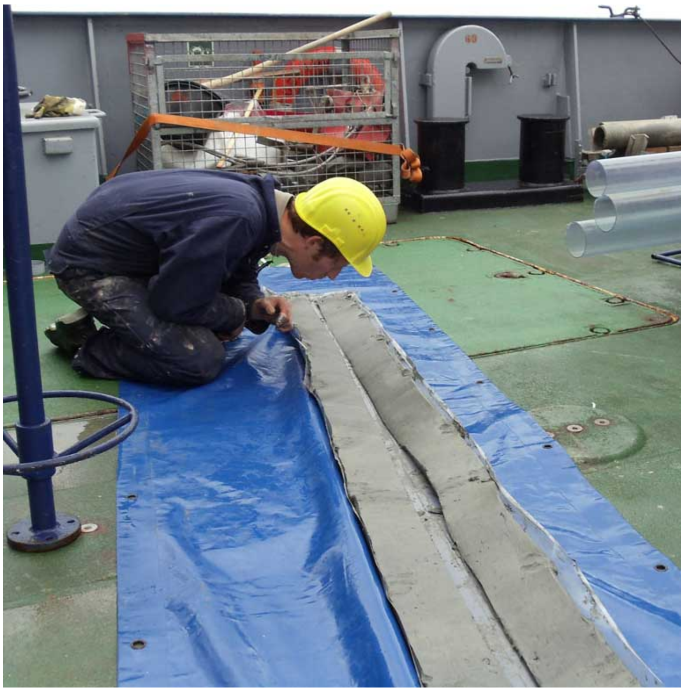

Fig. 4.4-5: Plastic hose core ("Schlauchkern") cut into two halves for visual core inspection

We used the IOW gravity corer with a core diameter of 12 cm and a barrel weight of ~1.8 tons. The corer was lowered with 1 m/s to the seafloor. The devices remained at seafloor for about 20 seconds in order to allow for deep penetration, then pulled out with a speed of 0.2 m/s. Heave velocity was 1.0 m/s.

The core liners of the gravity cores were orientated, then labelled, and commonly cut into 1 m sections. Before closing the core segments with plastic caps, small samples were taken from the core catcher and selected segment tops for biostratigraphic analyses (chapter 4.5) and initial carbonate content determinations, which were performed using 15%-hydrochloric acid. The cores were stored in a reefer container at a temperature of 4° C and transported to the IOW Warmenünde.

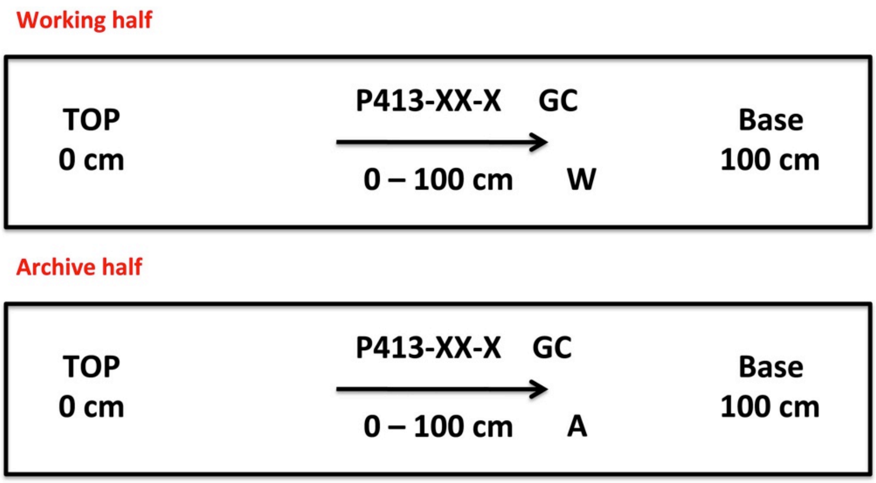

Fig. 4.4-6: Labelling of gravity core liners.

Sediment cores in the different working areas.

Coring was very difficult in working area 1 in the Corsica Strait. This area has been chosen in order to sample known cold water corals (Corradi et al., 1984). At the first station (P413/1), the coring device tumbled on the sea-floor and returned twice nearly empty. At the second station, two cores could be recovered (P413/2-1; plastic hose core (not sampled) and P413/2-2 with a core length of 116 cm (bent tube). A final attempt at station P413/3 was again unsuccessful and the corer again fell down at the sea floor.

In working area 2 (Fig. 4.4-7) in the eastern Ligurian Sea, coring was very successful. Here, we could complete a long depth transect from the deepest water depth close to the centre of the Gulf of Genoa (P413/60) across the continental slope (P413/4-7; P413/15; P413/19; P413/61) to shallow water depths on the comparatively wide shelf in this area (P413/8-14; P413/16-18). Core lengths varied between 5 and 9 m in the basin and at the continental slope and ca. 1.5 and 5 m on the shelf. We expect that the shelf cores will cover Holocene time intervals with different time-resolution, whereas the slope cores will likely go back into the last glacial and partly into Marine Isotope Stage (MIS) 5 (see 4.5).

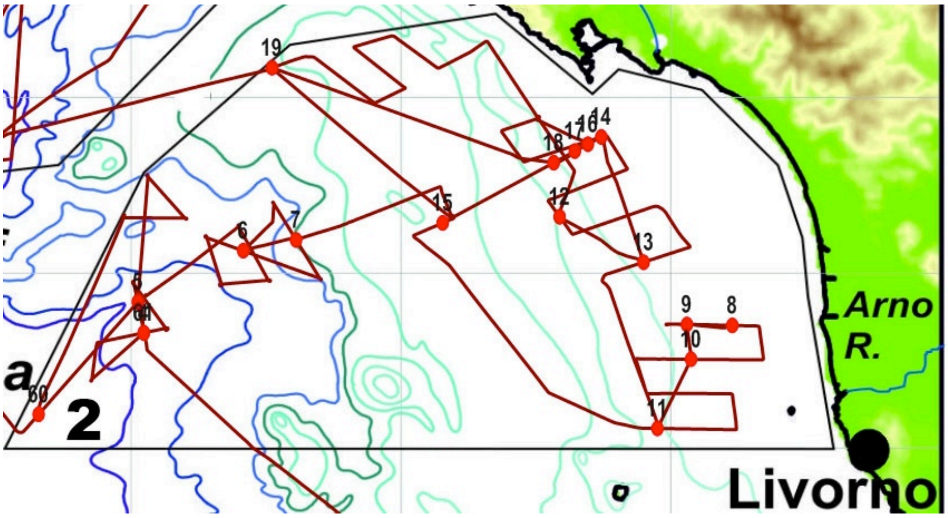

Fig. 4.4-7: Stations in working area 2 in the eastern Ligurian Sea.

The focus in working area 3 (central Gulf of Genoa; Fig. 4.4-8) was to sample the Holocene sediment deposition centers on the shelf (located off the mouths of local rivers) known from earlier shallow seismic studies (Corradi et al., 2004) (Fig. 4.4-9 and 4.4-10). Two transects across these high sedimentation rate areas on the shelf were cored directly west (P413/25-27) and east of the Portofino Promontory (Golfo de Tiguillio; P413/20-23), the latter extending down to the upper continental slope (P413/24).

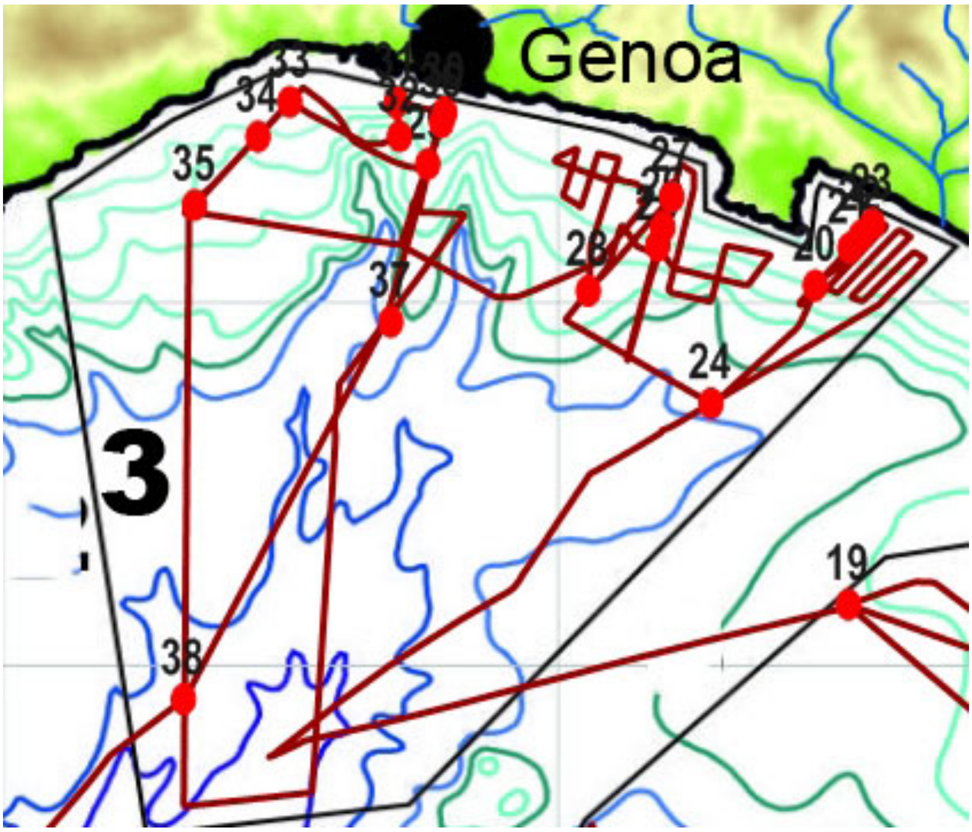

Fig. 4.4-8: Stations in working area 2 in the eastern Ligurian Sea.

Our sediment echosounder data largely confirm the extension of the shelf deposition centers and additionally show a pronounced tectonic segmentation of the lower shelf and the presence of a terrace most likely formed during the Last Glacial Maximum (LGM) (Fig. 4.4-9). Core lengths on the shelf varied between 2.5 and 5 m, whereas the slope core reached a length of more than 8 m.

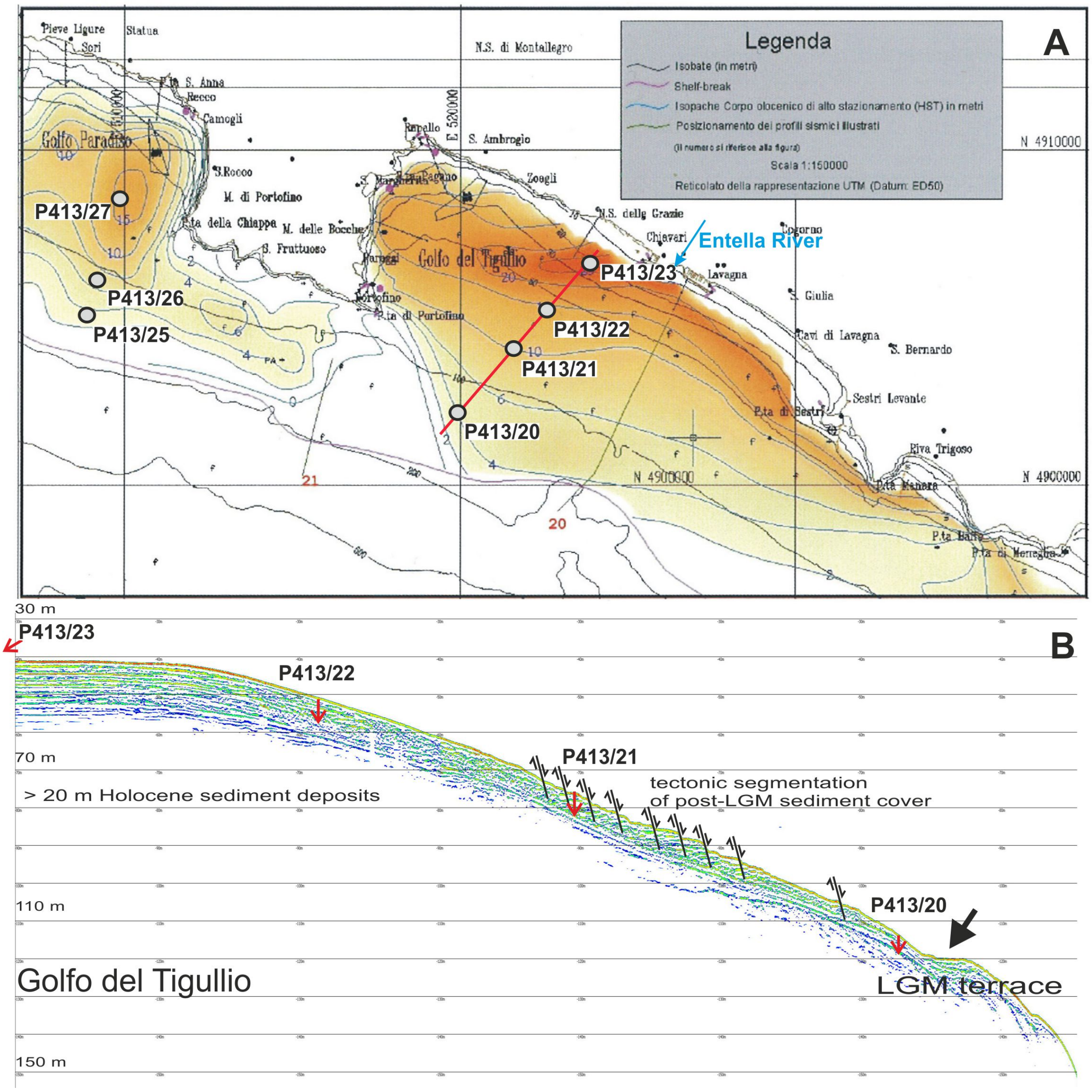

Fig. 4.4-9: (A) Thickness of Holocene sediments in the Gulf of Tigullio (Corradi et al., 2004) with core locations during cruise P413. (B): Shelf transect in the Golfo del Tigullio with coring stations.

Further west directly offshore the city of Genoa, we obtained additional cores from the shelf mostly located close to the centres of Holocene high accumulation areas (Fig. 4.4-10) (P413/29-30; P413/33-34; P413/36 with core lengths 2-4 m). Two sediment cores at the upper continental slope (P413/35 and P413/37; both more than 7 m long) and one core at the lower slope (P413/38; 6.4 m long) completed the coring in this area.

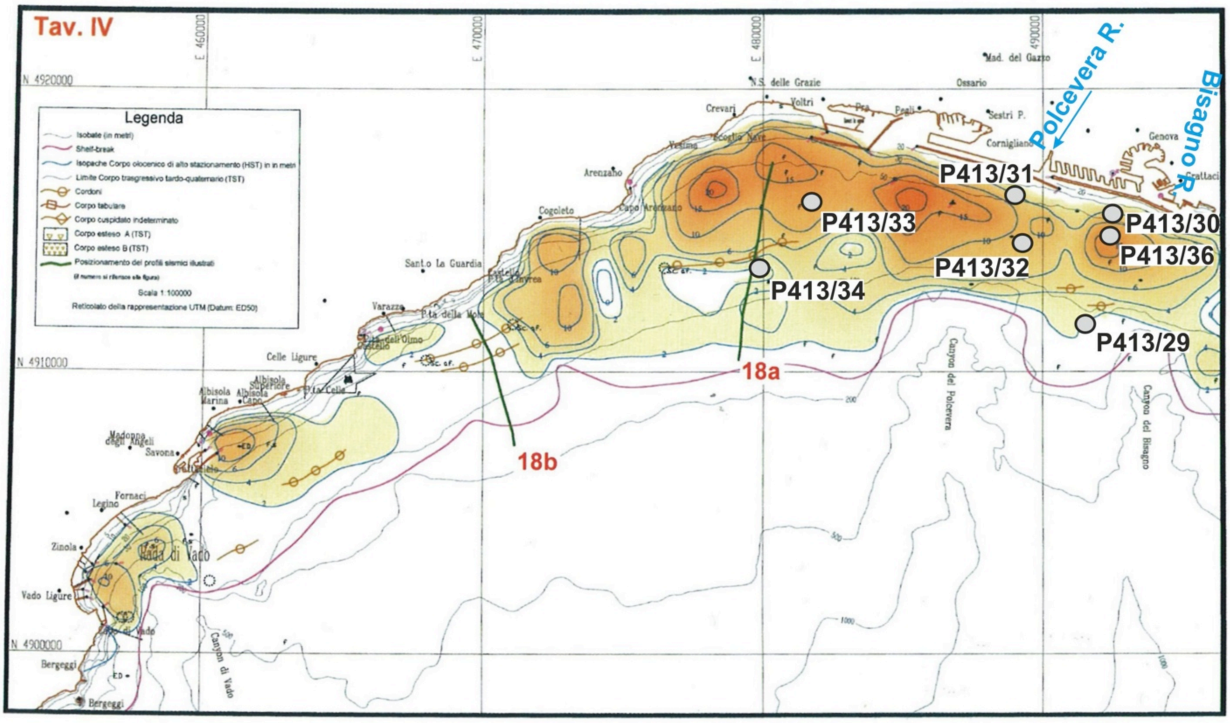

Fig. 4.4-10: Thickness of Holocene sediments off Genoa (Corradi et al., 2004) with core locations during cruise P413.

Working area 4 (Fig. 4.4-11), is characterized by a very narrow shelf and a steep slope frequently incised by submarine canyons. Therefore, the sediment echosounder search for coring stations resulted much more difficult. However, also in this area smaller-scale Holocene deposition centres have been previously mapped (Corradi et al., 2004) that occur off the mouths of the Roya and Argentina rivers both draining the Ligurian Alps. Gravity cores at stations P413/39-42 (core length between 3 and 5 m) provide a shelf transect into a Holocene deposition center off the mouth of the Roya River (Fig. 4.4-13). Further to the east, two cores have been retrieved from a smaller mud lense (P413/44, 4 m long; P413/51, 1.4 m long) and two cores off the Argentina river (P413/48-49; both ca. 4 m long). In the easternmost part of working area 4, two more relatively short cores (1.3-2.3 m) from shallow water depths were retrieved off Imperia (P413/55 and P413/57).

Furthermore we obtained three sediment cores (P413/45, P413/52, and P413/58) from the upper continental slope at water depths between 200 and 500 m that reach core lengths of 4 to 5.5 m. Finally three long sediment records have been retrieved close the base of the continental slope (Fig. 4.4-12) and in the Ligurian basin at water depths between 1700 and 2240 m. These three cores are between 6 and 7 m long (P413/46, P413/53, and P413/60).

Taken together cruise P413 obtained a dense network of sediment cores around the Gulf of Genoa. These include the easternmost Ligurian Sea shelf with extensive Holocene sediment cover. In the central and western Gulf of Genoa, shelf width and terrigenous sediment input diminishes significantly resulting in more restricted Holocene deposition centres that have been extensively cored. Furthermore we could accomplish depth transects from the Ligurian basin across the continental slope in particular in working 2. These cores likely reach into the last glacial and partly beyond into MIS 5.

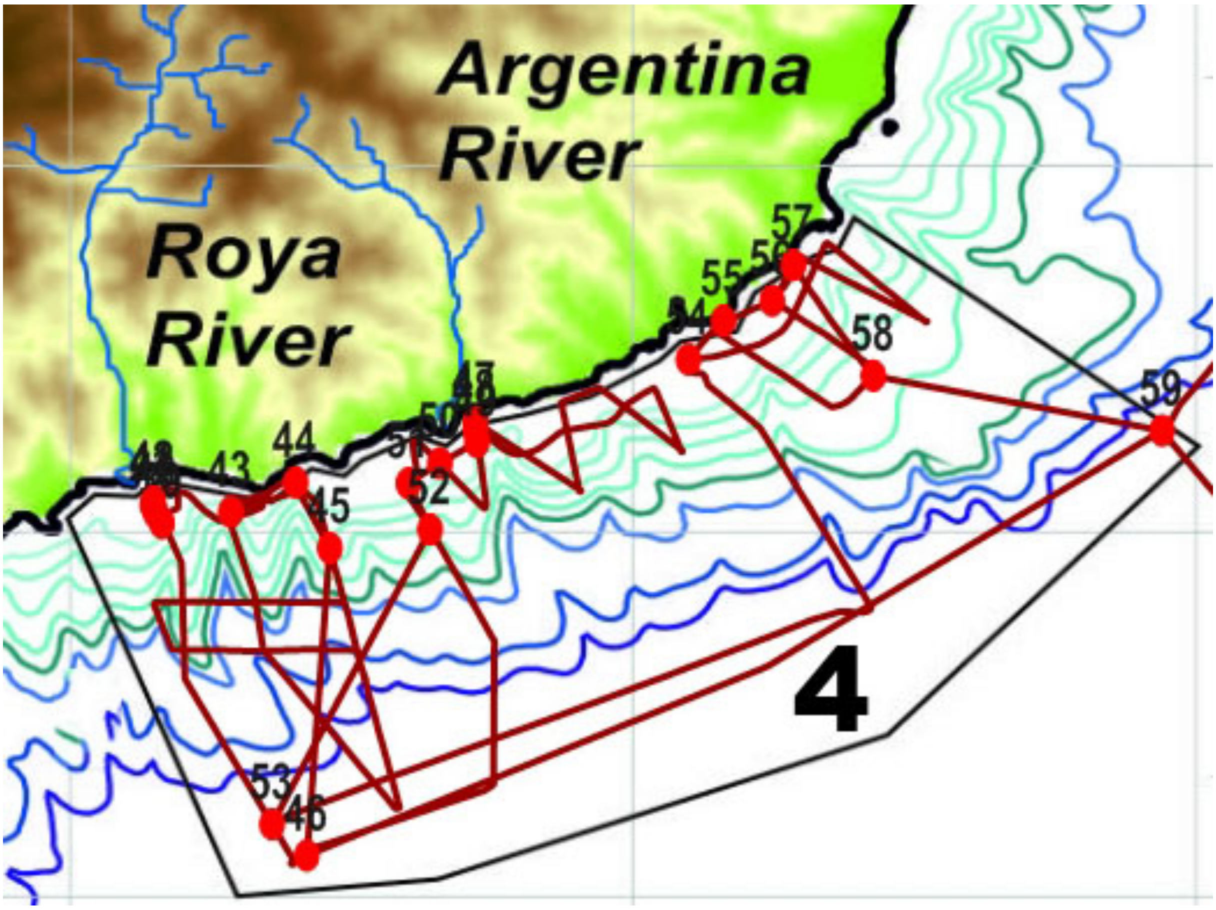

Fig. 4.4-11: Stations in working area 2 in the eastern Ligurian Sea.

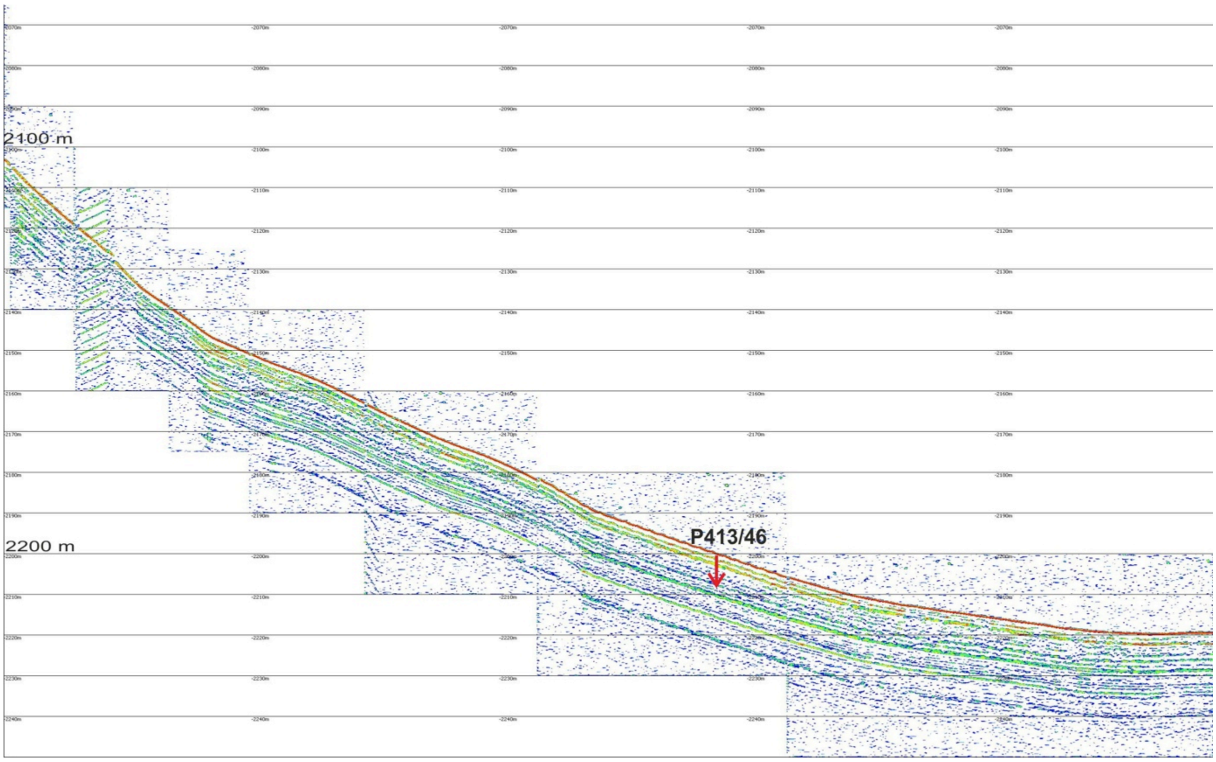

Fig. 4.4-12: Example of sediment echosounder profile close to the base of the continental slope in the westernmost working area 4 (station P413/46).

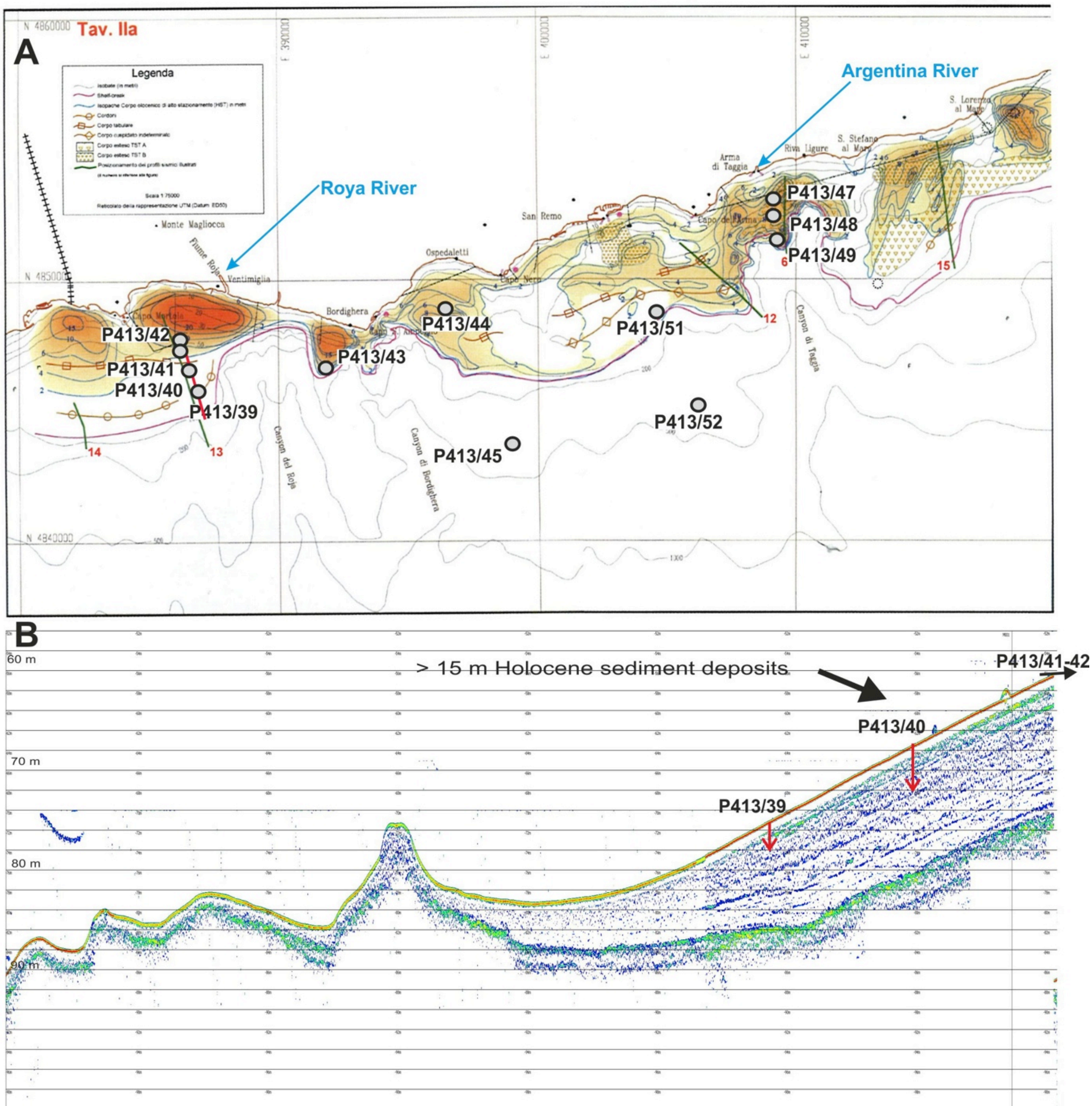

Fig. 4.4-13: (A) Thickness of Holocene sediments on the western Ligurian shelf (Corradi et al., 2004) with core locations during cruise P413. (B): Shelf transect off the mouth of the Roya River with coring locations.

Station No.	Latitude N (deg/min)	Longitude E (deg/min)	Area	Water depth (m)	Core recovery (cm)
P413/1-1	43° 14.41'N	9° 36,59' E	1	363	-
P413/1-2	43° 14,40' N	9° 36,60' E	1	361	20
P413/2-1	43° 13,75' N	9° 36,55' E	1	371	300
P413/2-2	43° 13,75' N	9° 36,55' E	1	371	116
P413/3-1	43° 13,96' N	9° 36,37 E	1	400	25
P413/4-1	43° 39,75' N	9° 1,90'	2	1859	514
P413/4-2	43° 39,75' N	9° 1,92' E	2	1859	828
P413/5-2	43° 42,43' N	9° 1,25' E	2	1738	874
P413/6-1	43° 46,84' N	9° 12,93' E	2	1287	646
P413/7-2	43° 47,77' N	9° 18,78' E	2	747	680
P413/8-2	43° 40,39' N	10° 7,08' E	2	32	410
P413/8-4	43° 40,40' N	10° 7,09' E	2	32	468
P413/9-2	43° 40,47' N	10° 2,05' E	2	79	**-**
P413/9-5	43° 40,47' N	10° 2,05' E	2	78	155
P413/11-1	43° 31,507' N	9° 58,792' E	2	147	430
P413/12-5	43° 49,763' N	9° 47,957' E	2	214	543
P413/14-4	43° 56,648' N	9° 52,577' E	2	37	423
P413/15-1	43° 49,236' N	9° 35, 013' E	2	426	635
P413/16-4	43° 56,032' N	9° 51,091' E	2	61	**-**
P413/17-1	43° 55,425' N	9° 49,658' E	2	81	**-**
P413/17-2	43° 55,436' N	9° 49,648' E	2	81	491
P413/18-2	43° 54,436' N	9° 47,309' E	2	116	405
P413/19-1	43° 2,629' N	9° 16,112' E	2	662	687
P413/20-3	44° 16,003' N	9° 14,339' E	3	113	250
P413/20-4	44° 16,002' N	9° 14,330' E	3	113	301
P413/21-4	44° 17,563' N	9° 16,200' E	3	69	400
P413/21-5	44° 17,577' N	9° 16,201' E	3	70	516
P413/22-4	44° 18,088' N	9° 16,798' E	3	51	486
P413/23-8	44° 18,588' N	9° 17,410' E	3	25	430
P413/24-1	44° 11,061' N	9° 8,730' E	3	853	808
P413/25-2	44° 17,687' N	9° 5,867' E	3	115	250
P413/25-3	44° 17,683' N	9° 5,856' E	3	115	523
P413/26-2	44° 18,442' N	9° 6,139' E	3	103	240
P413/28-1	44° 15,799' N	9° 2,188' E	3	465	-
P413/28-2	44° 15,775' N	9° 2,182' E	3	462	712
P413/29-3	44° 21,087' N	8° 53,497' E	3	106	300
P413/29-4	44° 21,094' N	8° 53,496' E	3	106	406
P413/30-5	44° 23,255' N	8° 54,407' E	3	51	355
P413/33-6	44° 23,699' N	8° 46,078' E	3	68	412
P413/34-3	44° 22,249' N	8° 44,367' E	3	88	196
P413/35-1	44° 19,375' N	8° 40,959' E	3	196	719
P413/36-7	44° 22,844' N	8° 54,234' E	3	67	-
P413/37-1	44° 14,480' N	8° 51,511' E	3	729	773
P413/38-2	43° 58,662' N	8° 40,36' E	3	1697	640
P413/39-4	43° 45,289' N	7° 35,704' E	4	72	250
P413/39-5	43° 45,272' N	7° 35,681' E	4	71	267
P413/40-3	43° 45,687' N	7° 35,361' E	4	62	445
P413/41-5	43° 46,02' N	7° 35,18' E	4	51	492

Station No.	Latitude N (deg/min)	Longitude E (deg/min)	Area	Water depth (m)	Core recovery (cm)
P413/42-4	43° 46,165' N	7° 35,225' E	4	47	516
P413/44-4	43° 46,975' N	7° 42,775' E	4	64	400
P413/44-5	43° 46,963' N	7° 42,787' E	4	65	422
P413/45-4	43° 44,240' N	7° 44,598' E	4	282	514
P413/46-1	43° 31,534' N	7° 43,387' E	4	2199	665
P413/48-4	43° 49,12' N	7° 52,33' E	4	57	450
P413/48-5	43° 49,125' N	7° 52,331' E	4	57	453
P413/49-4	43° 48,629' N	7° 52,421' E	4	93	368
P413/51-2	43° 46,924' N	7° 48,777' E	4	87	135
P413/52-1	43° 45,017' N	7° 49,927' E	4	374	387
P413/53-1	43° 32,81' N	7° 41,53' E	4	2201	716
P413/55-6	43° 53,657' N	8° 5,500' E	4	34.3	-
P413/55-7	43° 53,660' N	8° 5,507' E	4	35	100
P413/57-4	43° 55,955' N	8° 9,220' E	4	37	231
P413/58-1	43° 51,365' N	8° 13,476' E	4	510	500
P413/58-2	43° 51,373' N	8° 13,477' E	4	510	530
P413/60-2	43° 32,72' N	8° 50,27' E	2	2240	609
P413/61-1	43° 39,747' N	9° 1,913' E	2	2002	429
Sum					**247.66 m**

GC3, 6, 9, 12: Gravity core with different barrel lengths
GCxS: Core with plastic-hose instead of liner (“Schlauchkern”). These cores have not been stored

Table 4.4-3: Deployed Gravity-corer with core recovery.

4.5. Preliminary Biostratigraphic Results - Planktic Foraminiferal Analyses and Biostratigraphy from Sand Fractions in Surface Sediments and Core Catchers *(H. Schulz)*

About 1-2 ccm of sediment was taken immediately after recovery from a variety of sediment levels, including multicore/Frahm Corer tops and bases, and the top levels of long cores and core catchers (cc). Sediments were carefully washed through a 63-µm-screen with tab water. The residue was dried over night at 60°C in glass Petri dishes and examined under a binocular of 20-60x magnification.

Most sediment samples originate from the Late Holocene marine sedimentary wedge, characterized by well-sorted sands shifting further offshore towards less sorted muddy fine sands and muds. These sediment types usually mark environments between 20 to 100 m present water depth, within the depth range were most sediment cores were taken. Only a relatively small number of sites have targeted the outer shelf and steep slopes immediately below the shelf break. Another group of samples represents hemipelagic sediments with a variable content of terrigenous fraction, but usually with a high concentration of planktic foraminifera which allow for a more detailed analysis of the deeper sites.

We are aware that the analyses are based on the relatively small volume of bulk sample, and the coarse fraction may make only a few weight-%. Nevertheless, the purpose was to obtain a first overview on the recovered material. For instance, we focused on the presence of warm and cold water planktic foraminifera and pteropods, that may be useful as indicator species of Holocene,or Late Pleistocene, or even older age. Table 1 show the results from the planktic foraminiferal analyses and Table 2 of a total of more than 70 levels inspected coarse fractions.

4.5.1 Results

The majority of samples represents dark brown to light-brown colored muds, with a large range in the sand fraction, which typically is composed of quartz, muscovite, and a highly variable amount of biogenic components. These are mostly molluscs, bryozoans, echinids and pteropods. Nearly all sediments from shallow depths contain an obvious fraction of marine plant debris. Sometimes, terrestrial plant material might have been preserved in addition to the frequent wood and wood fragments. In most cases, the plant fraction was reduced in the core catchers samples when compared to core tops from the same station. Some samples, in addition to plastic particles and artificial rocks, show a distinct fraction of black minerals, slack and iron spheres, suggesting anthropogenic contamination. Towards deeper sites near the shelf edge, some samples contain a high fraction of bioclasts and can be grouped as carbonate sands with a greenish/turquoise colored mineral phase that also appeared as staining. A third group reflects the deeper hemipelagic sites at the upper slope down to more than 2200m water depth. In these sediments, the more detailed foraminiferal analyse were possible.

In order to concentrate on the larger size fraction of planktic foraminifera, the coarse fraction was carefully rolled over an oblique floor of a Petri dish, with the larger fraction accumulating at the lower side. We estimate that by this primitive procedure, intact specimens of the size fraction of ~>200 µm could be separated. Home-based analyses using more advanced washing, sieving and splitting methods may show the robustness of this rough method.

In core SL125 (43° 39`N; 009° 01`E, ~1800 m water depth; 224cm long) Testa et al. (1990) present first PF percentage data from the North-Eastern Ligurian Sea spanning the regional warm and cold assemblages of the past 30,000 years. Foraminiferal counts were performed on the size fraction>200 µm. We followed the bioclimatic scheme of Testa et al. (1990) grouping the PF species into:

(1) cold water indicators: *Globigerinoides bulloides*, *Neogloboquadrina pachyderma* (sinistral and dextral), *Globorotalia scitula*)

(2) warm water indicators: *Globorotalia inflata*; *Globorotalia truncatulinoides* (sinistral and dextral), *Globigerinoides ruber* (white), *Orbulina universa*, *Hastigerina* ssp., *Globigerinoides sacculifer.*

A number of species not included in this scheme have been well recorded. These species/categories include: *Globigerinoides ruber* (pink), *Beella digitata*, *Turborotalia quinqueloba*, *Globigerinita glutinata*. *Globigerinoides ruber* and *Beella digitata* occurred in some samples in only low numbers of less than 5 specimens.

The small species *Turborotalia quinqueloba* was found in a few samples in significant numbers. Since size of that cold species rarely exceeds 200 µm, it was taken as a size indicator in our counting procedure, as it was also indicated by the occasional occurrence of the warm species *Globigerina rubescens* and *Globigerinoides tenella.* Planktic foraminiferal specimens in a size similar to these three species were not counted. This may help to a more consistent data set. Accordingly, any of these three species is absent from the faunas of > 200 µm reported by Testa et al. (1990). Their data could be used to estimate the ages of several multicores and sediment cores with high sedimentation rates of the past 30,000 years. However, in became evident, that the faunas determined from supposed older intervals cannot be explained by the species frequency combinations of Testa et al., (1990). For instance, there is no information available on the faunal composition of the last interglacial (70,000 to 125,000). Analyses of stable isotopes are necessary for a more precise biostratigraphic schemes in the Ligurian Sea.

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Sample	Water Depth	Level	Sum Counted	G.sipho. (%)	G.sacculifer (%)	Gt.trunc.dex (%)	Gt.trunc.sin (%)	O.universa (%)	G.ruber pink (%)	G.ruber white (%)	Gt.inflata (%)	G.bulloides (%)	N.pach.dex (%)	N.pach.sin (%)	Gt.scitula (%)	Other PF
4-1GC6	1859	cc	323	0						1	5	81	7	5		2
4-2GC12	1859	cc	342	3				8		29		56	4			1
5-2GC12	1738	cc	317	1				3		7	6	50	19	1		13
5-1MUC	1738	25cm	278	0	0	3		5		6	34	13	38			
6-1GC12	1287	cc	241							0	10	68	12			10
6-2MUC	1288	0-1	494	1		0	9	3	0	4	14	21	45	0		2
11-1GC6	154	top	59		2		10	5		34	7	41	2			
15-1GC12	460	cc	156							1	6	82	8	1		3
15-2MUC	431	0-1	117	2	1		6	11	1	3	14	38	24			
18-2GC9	118	cc	73	1	3		3	5	3	30	10	32	14			
19-1GC12	662	cc	231					3			9	79	6			3
19-3MUC	657	ofl	176	1	0	1	15	4	1	6	11	24	35			2
20-1FC	113	base	54	7	2			4	2	48	2	35				
24-1GC12	853	cc	260									89	5		2	4
28-2GC12	462	cc	72							3		79	10	1	3	4
37-1GC12	68	cc	209							2		74	5	1	6	11
38-2GC12	1697	cc	271							3		40	24	1		33
46-1GC12	2199	cc	267				0					65	8	1		26
53-1GC12	2201	cc	93								1	47	15			37
58-1GC6	553	50	57		2		12	7		7	16	35	21			0
58-1GC6	553	100	54					7	0	20	22	35	9			6
58-1GC6	553	150	186		1			7	4	20	13	23	26			6
58-1GC6	553	250	110		1					4	12	18	31			35
58-1GC6	553	cc	144							1		73	13	6		6
60-2GC12	2240	cc	90	1				6		1	19	32	40			1
61-2GC12	2202	cc	141	1				7		1	26	45	18			1

Tab. 4.5-1: Results of foraminiferal analyses

Sample	Water Depth [m]	Re-covery [m]	Sampled Level	Main Components of Coarse Fraction	Secondary Components	Biogenic Fraction & Accessory	Suggested Age	Remarks
4-1GC6	1859	5.14	cc	*Foraminiferal Ooze*			Cold Stage 4	see 4.5-1
4-2GC12	1859	8.28	cc	*Foraminiferal Ooze*			Warm Stage 5	see 4.5-1
5-1MUC	1737	0.28	25cm	*Foraminiferal Ooze*			LATE HOLOCENE	see 4.5-1
5-2GC12	1738	8.74	cc	*Foraminiferal Ooze*			Termination ?5/6	see 4.5-1
6-1GC12	1287	6.46	cc	*Foraminiferal Ooze*		*Cold Water Pteropods*	Stage 4/Early Stage 5	see 4.5-1
6-2MUC	1288	0.26	0-1	*Foraminiferal Ooze*			LATE HOLOCENE	see 4.5-1
8-1FC	32	0.70	base	*Quartz, Muscovite*	*Plant Debris*	*Some PF*	LATE HOLOCENE	
9-3FC	79	0.70	base	*Quartz, Muscovite*	*Plant Debris, Biogenic Carbonate*	*rich BFF, Sponge Spicules*	LATE HOLOCENE	
11-1GC6	147	4.30	top	*Quartz Sand*	*Carbonate Bioclasts*	*BFF, Pyrite Small, only juvenile PF*	HOLOCENE	
11-1GC6	147	4.30	cc				Warm (?Stage 5)	see 4.5-1
14-4GC6	37	4.23	cc	*Plant Debris, Muscovite*		*BFF, no PF*	?HOLOCENE	
15-1GC12	426	6.35	cc			*Cold Water Pteropods*	COLD STAGE (4)	see 4.5-1
15-2MUC	431	0.43	top				Late HOLOCEN	see 4.5-1
16-4GC3	61	??	cc	*Muscovite, Plant Debris*	*Quartz Sand*	*PF: G. ruber well preserved*	HOLOCENE	rich BF
17-2GC9	81	4.91	top	*Plant Debris, Wood, Muscovite*	*Quartz*	*G. ruber pink; G. bulloides, Gt. trunc. sinistral, ?N. incompta*	HOLOCENE	Diverse PFF
18-2GC9	116		cc	*Biogenic Carbonate Sand*	*Quartz*	*Bryozoans, BFF; High Fraction "warm" PF*	EARLY HOLOCENE Possibly Eemian	see 4.5-1

Tab. 4.5-2: Results of sand fraction analyses

Tab. 4.5-2 (continued)

19-1GC12	662	687	cc	*Foraminiferal Ooze*	*Quartz, some Muscovite*		Cold Stage ?4	see 4.5-1
19-3MUC	657	0.39	0-1			*Deep Bioturbation*	LATE HOLOCENE	see 4.5-1
20-1FC	113	max	base	*Carbonate Sand*	*Some Quartz*	*Rich BFF, Pteropods Gt. inflata, T. quinqueloba*	? EARLY HOLOCENE (Schelf)	see 4.5-1
20-4GC6	113	301	cc	*Quartz-Muscovite Sand, Wood and Plant Debris*	*Black Monosulfides*	*Diverse BFF and PFF Some large G. bulloides and Neogloboquadrinids*	HOLOCENE	
21-1FC	69	max	base	*Quartz Sand, Muscovite, Plant Debris*	*Calcite Shells and Fragments of Megafossils*	*Some BFF and PF: G. sacc, Gt. trunc sinistral, G. bull.; No G. ruber, no Neogloboquadrinids*	HOLOCENE	
21-4GCS	69	400	cc	*Quartz Sand, Muscovite Plant Debris*	*Calcite Shells and Fragments of Megafossils*	*Some PF: G. ruber, O. unviversa, Gt. inflata*	HOLOCENE	
21-5GC9	70	516	cc	*Quartz Sand with large Bryozoan and Mollusc Fragments*	*Pteropods, Ostracods, Plant Debris*	*BFF; PF: G. siphonifera, G. bull., O. universa, G. ruber, Gt. inflata*	HOLOCENE	
22-1FC	52	rest	base	*Plant Debris, small Lithic Fraction*	*Plant Roots*	*Low Diverse BFF*	HOLOCENE	
22-4GC9	51	486	cc	*Plant Debris and Wood, small Lithic Fraction*	*Some more Lithics than 21-1FC*	*Large Bisaccate Pollen Grains, Echinoderms*	HOLOCENE	
23-4FC	26	20	base	*Biogenic Carbonate Sand, Muscovite*	*Agglomerates of Organic Micas, Megafossils*	*Small Fragments of red and blue Plastics No PF*	LATE HOLOCENE	Anthropogenic Contamination
23-8GC6	25	430	cc	*Low Coarse Fraction Dominant Organic Fraction (Plant Debris and Wood*	*Muscovite*	*BFF mostly of well preserved Elphidium No PF*	LATE HOLOCENE	Good Preservation

Tab. 4.5-2 (continued)

24-1GC12	853	808	cc			*Pyrite in faecal pellets and small burrows Cold Water Pteropods*	?STAGE 3	see 4.5-1
25-3GC6	115	250	cc	*High Fraction of fragmented ?Serpulid Tubes*	*Grey Quartz Sand with Muscovite, Mollusc Debris*	*Pyrite; BFF, no PF*	LATE PLEISTOCENE	
26-2GC9	103	240	cc	*Quartz, Muscovite, Plant Debris and Wood*	*Molluscs, Echinid Spines, Ostracods*	*BFF with Elphidium, poor PF*	? HOLOCENE	Rich Sample
27-4GC	77	403	cc	*Grey Quartz Sand,*	*Plant Debris (?Sea Gras) ? Serpulids, Megafossils*	*BFF, PF: G. ruber pink, G. bull., N. Incompta*	LATE HOLOCENE	Rich Sample
28-2GC12	462	712	cc	*Grey Quartz Sand*	*Ophiur Remains*	*BF and PF present*	Cold ?STAGE 3/4	see PF report
29-4GC6	106	406	top	*Immature Quartz Sand, Muscovite-Grey ?Gneiss Fragments*	*Molluscs, "fresh" Woods Fragments*	*Faecal Pellets, BFF Few PF: Gt. trunc. Sinistral, G. bull., G. siphonifera, O. uuniv.*	HOLOCENE	Poorly Sorted
29-4GC6	106	406	cc	*Carbonate Sand, Bryozoans*	*Molluscs Typical greenish stained Fillings of Pteropod- and BF-Shells*	*BFF (Elphidium) PF present No Neogloboquadrinids*	EARLY HOLOCENE ?PLEISTCENE	?Glauconitic Mineral Phases
30-2FC	51	55	base	*Immature, inhomogeneous Quartz Sand, Black ?Lithic Fragments, Anthropogenic, Glass, Slack, Ceramics*	*Faecal Pellets, Wood and Plant Debris, Molluscs*	*?Pyrite Metals BFF*	LATE HOLOCENE	Anthropogenic Contamination
30-5GC12	51	355	top	*Plant Debris "?Sea Grass", Structured Plant Fragments*	*Quartz and Biogenic Sand*	*?Reworked Green Sands (see 29-4GC6)*	HOLOCENE/ ?REWORKED LATE PLEISTOCENE	
33-6GC12	68	412	top	*Quartz-Muscovite Sand with Plant Debris*	*Black Components ?Minerals/Contaminants*	*Oil (after heating) BFF, Diatoms, Ostracods; no PF*	LATE HOLOCENE	Anthropogenic Contamination

Tab. 4.5-2 (continued)

33-6GC12	68	412	cc	*Well-sorted grey Quartz Sand/ Muscovite and Wood Fragments*	*Bryozoan Fragments; thick-shelled Molluscs;*	*BF, Ostracods; Pteropods; No PF*	HOLOCENE	
34-3GC6	88	196	cc	*Biogenic Carbonate Sand with thick Shell Fragments*	*Fraction of Rounded Quartz (1-2mm)*	*Poor BF Preservation Some PF: O. universa*	?PLEISTOCENE	Inhomogeneous ?Reworking
35-1GC12	196	412	cc	*Well-sorted grey Quartz/Muscovite Sand*	*Large Bioclast Fragments (?Bryozoans)*	*Cold Water Pteropods; No "Green Sand" Some BF; No PF*	?LAST GLACIAL	
36-1FC	67	30	base	*Poorly sorted, Lithic Fragments, Slag*	*Plant Debris, Molluscs; BFF, Ostracods, Pteropods*	*PF: G. bull O. universa Anthropogenic Metal Spheres*	HOLOCENE	Anthropogenic Contamination
36-7GC9	67	0	cc	*High Coarse Fraction Content; Grey Quartz Sand*	*Biogenic Carbonate: Molluscs, Bryozoans, Wood and Plant Debris*	*BFF, Pteropods; PF: O. universa, G. ruber; "Green Sands"*	?LATE PLEISTOCENE	Banana Stiff Sediment
37-1GC12	729	773	cc			*Cold Water Pteropods*	?STAGE 2	see 4.5-1
38-2GC12	1697	640	cc			*High Lithic Fraction*	Warm Stage 3/?5	see 4.5-1
39-1FC	71	60	base	*Quartz/Biogenic Sand + Mollusc Fragments*	*Wood Fragments, Pteropods*	*PF: Gt. trunc sinistral G. sacc., G. bull*	Late Holocene	?Some Anthropogenic Admixture
39-4GC3	72	50	cc	*Coarse Carbonate Sand*	*Quartz, "Green Sand" Some Lithic Fragments*	*Very Coarse Mollusc/ Bryozoan Fragments Sub-Rounded Lithic F.*	PLEISTOCENE	
40-1FC	62	50	base	*Grey to Brown Quartz Sand*	*Thin-shelled Mollusc and Pteropod Debris*	*BF, Plant Debris; Ostracods*	HOLOCENE	
40-3GC6	63	445	cc	*Medium Grey Quartz Sand, some Muscovite*	*Coarse Mollusc and Bryozoan Fragments*	*Some Wood and Plant Debris*	Limacinid Pteropods; Ostracods,	?PLEISTOCENE

Tab. 4.5-2 (continued)

41-5GC9	51	492	cc	*Low Coarse Fraction Content; Quartz/ Muscovite Sand*	*Wood and Plant Debris*	*Pyrite* *BF; bisaccate Pollen*	HOLOCENE	Large Pollen!
42-1FC	47	?60	base	*High Sand Fraction of Quartz and Wood Fragments.*	*Plant Debris*	*Low Carbonate Fraction* *Some Molluscs*	?HOLOCENE	
42-4GC9	47	516	"Muffe"	*sea grass*				
42-4GC9	47	516	cc	*Quartz-Muscovite-Sand*	*Wood and Plant Debris* *Thick-shelled Bryozoa and Molluscs*	*PF: O. universa*	HOLOCENE	
44-5GC6	65	422	cc					
45-3FC	284	70	base	*(Pteropod)-Debris with Quartz and BF*	*Plant Debris and Wood*	*?Serpulids; PF: Gt. trunc sinistral, Gt. inflata, G. ruber, G. bull.*	HOLOCENE	Deep Bioturbation
45-4GC6	382	514	cc	*Coarse Biogenic Fraction*	*Large BF (Pyrgo) and Rounded Biogenic Carbonate Particles*	*Molluscs, Bryozoa; ?Serpulids, Brachiopods* *BF: some green-stained Shells*	PLEISTCENE	Reworked
46-1GC12	2199	665	cc				Cold ?STAGE 3/4	see 4.5-1
48-4GC6	57	450	cc	*Quartz-Muscovite Sand; high Fraction of Plant Debris*	*Some Shells of Molluscs and Bryozoa*	*Large Wood Fragments* *Ostracods; Pyrite*	HOLOCENE	
49-1FC	93	60	top	*Silty Texture with small Coarse Fraction*			??	
49-1FC	93	60	base	*Light-colored Quartz-Muscovite Sand*	*BF, Plant Debris, Wood,*	*Gt. trunc. sinistral; G. ruber, G. glutinata, G. bull., Neogloboquadrina.*	HOLOCENE	

Tab. 4.5-2 (continued)

49-4GC6	93	368	cc	*Low Sand Content Quartz Sand, some Muscovite*	*BF, Wood, Plant Debris; Pteropods, ?Serpulids, Ostracods, Echinoderms*	*No PF ??Possibly some Volcanic Ash?*	HOLOCENE	
51-2GC6	87	135	cc	*High Sand Content of coarse Bioclasts*	*Pteropods, Rounded Lithoclasts incl. Quartz*	*Low BF; PF: G. ruber pink, O. universa*	(Late)PLEISTOCENE	
52-1GC6	374	387	top	*Light-colored Quartz-Muscovite Sand*	*Pteropod Shells, Echinoderms; BFF*	*PF: Gt. trunc. sinistral; G. bull, O. universa, Gt. scitula, Gt. inflata*	HOLOCENE	
52-1GC6	374	387	cc	*Carbonate Sand, PF: G. bull., G. Glutinata, O. universa; G. ruber*	*Quartz Sand*	*Bioclasts, Ostracods*	HOLOCENE/ PLEISTOCENE	Reworked
53-1GC12	2201	716	cc			*Lithic Fraction*	Warm STAGE 3	see 4.5-1
56-1FC	48	0	rest	*Light-grey Quartz Sand, sorted with Plant Debris*	*Muscovite Some BFF (Elphidium)*	*Some Pteropods and Mollusc(fragment)s*	HOLOCENE	see 4.5-1
58-1GC6	553	500	50				Late HOLOCENE	see 4.5-1
58-1GC6	553	500	100				Mid HOLOCENE	see 4.5-1
58-1GC6	553	500	150				Late HOLOCENE	see 4.5-1
58-1GC6	553	500	250				Cool PLEISTOCENE	see 4.5-1
58-1GC6	553	500	cc				Cold STAGE 3/4	see 4.5-1
60-2GC12	2240	609	cc				Interglacial STAGE 5	see 4.5-1
61-1GC12	2002	429	cc				Warm STAGE3/5	see 4.5-1
PF=Planktic Foraminifera; BFF=Benthic Foraminiferal Fauna; G. bull.=G. bulloides;								

5. References

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6. Station List

Station No.	Gear	Date (UTC)	Start (UTC)	Latitude N (deg/min)	Longitude E (deg/min)	Area	Water depth (m)	Core recovery (cm)
P413/1-1	GC3S	12.05.11	10:03	43° 14.41'N	9° 36,59' E	1	363	-
P413/1-2	GC3S	12.05.11	10:45	43° 14,40' N	9° 36,60' E	1	361	20
P413/2-1	GC3S	12.05.11	11:41	43° 13,75' N	9° 36,55' E	1	371	300
P413/2-2	GC6L	12.05.11	12:38	43° 13,75' N	9° 36,55' E	1	371	116
P413/3-1	GC6L	12.05.11	14:28	43° 13,96' N	9° 36,37 E	1	400	25
P413/3-2	MN	12.05.11	15:15	43° 14,44' N	9° 37,33 E	1	327	-
P413/3-3	CTD	12.05.11	16:04	43° 14,4339' N	9° 37,3160' E	1	303	-
P413/4-1	GC6L	13.05.11	04:05	43° 39,75' N	9° 1,90' E	2	1859	514
P413/4-2	GC12L	13.05.11	06:11	43° 39,75' N	9° 1,92' E	2	1859	828
P413/4-3	MUC	13.05.11	08:30	43° 39,75' N	9° 1,90' E	2	1860,2	25
P413/5-1	MUC	13.05.11	10:45	43° 42,43' N	9° 1,24' E	2	1737	28
P413/5-2	GC12L	13.05.11	12:40	43° 42,43' N	9° 1,25' E	2	1738	874
P413/5-3	CTD	13.05.11	16:02	43° 43,0039' N	9° 02,1000' E	2	1718	-
P413/5-4	MN	13.05.11	06:15	43° 43,00' N	9° 2,09' E	2	1716	-
P413/5-5	MN	13.05.11	06:29	43° 42.995' N	09° 02.105' E	2	1716	-
P413/6-1	GC12L	14.05.11	05:03	43° 46,84' N	9° 12,93' E	2	1287	646
P413/6-2	MUC	14.05.11	06:44	43° 46,84' N	9° 12,92' E	2	1288	26
P413/7-1	MUC	14.05.11	08:45	43° 47,76' N	9° 18,75' E	2	750	28
P413/7-2	GC9L	14.05.11	10:31	43° 47,77' N	9° 18,78' E	2	747	680
P413/7-3	MN	14.05.11	12:00	43° 47,763' N	9° 18,775' E	2	746	-
P413/7-4	CTD	14.05.11	13:19	43° 47,7630' N	9° 18,7710' E	2	740	-
P413/8-1	FC	15.05.11	07:11	43° 40,392' N	10° 7,074' E	2	32	70
P413/8-2	GC6L	15.05.11	07:52	43° 40,39' N	10° 7,08' E	2	32	410
P413/8-3	FC	15.05.11	08:15	43° 40,39' N	10° 7,06' E	2	32	70
P413/8-4	GC12L	15.05.11	09:33	43° 40,40' N	10° 7,09' E	2	32	468
P413/8-5	FC	15.05.11	10:12	43° 40,38' N	10° 7,08' E	2	32	70

P413/8-6	FC	15.05.11	10:22	43° 40,396' N	10° 7,06' E	2	32	-
P413/8-7	FC	15.05.11	10:30	43° 40,39' N	10° 7,05' E	2	30	70
P413/9-1	FC	15.05.11	11:38	43° 40,473' N	10° 2,052' E	2	81	70
P413/9-2	GC12L	15.05.11	11:52	43° 40,47' N	10° 2,05' E	2	79	-
P413/9-3	FC	15.05.11	12:14	43° 40,47' N	10° 2,04' E	2	79	70
P413/9-4	FC	15.05.11	12:26	43° 40,47' N	10° 2,041' E	2	77	70
P413/9-5	GC6L	15.05.11	12:39	43° 40,47' N	10° 2,041' E	2	78	155
P413/10-1	FC	15.05.11	13:44	43° 37,47' N	10° 02,51' E	2	89	-
P413/10-2	FC	15.05.11	13:58	43° 37,47' N	10° 02,52' E	2	86	70
P413/11-1	GC6L	15.05.11	16:04	43° 31,507' N	9° 58,792' E	2	147	430
P413/11-2	FC	15.05.11	16:18	43° 31,508' N	9° 58,786' E	2	148	70
P413/11-3	FC	15.05.11	16:31	43° 31,507' N	9° 58,777' E	2	148	70
P413/12-1	FC	16.05.11	04:33	43° 49,8' N	9° 47,999' E	2	213	70
P413/12-2	FC	16.05.11	04:53	43° 49,763' N	9° 47,957' E	2	215	70
P413/12-3	FC	16.05.11	05:09	43° 49,761' N	9° 47,960' E	2	214	70
P413/12-4	FC	16.05.11	05:25	43° 49,757' N	9° 47,967' E	2	214	70
P413/12-5	GC9L	16.05.11	05:58	43° 49,763' N	9° 47,957' E	2	214	543
P413/13-1	FC	16.05.11	07:44	43° 45,848' N	9° 57,262' E	2	92	70
P413/13-2	FC	16.05.11	07:56	43° 45,838' N	9° 57,261' E	2	92	70
P413/14-1	FC	16.05.11	09:44	43° 56,654' N	9° 52,578' E	2	36	20
P413/14-2	FC	16.05.11	09:50	43° 56,655' N	9° 52,575' E	2	36	20
P413/14-3	FC	16.05.11	09:58	43° 56,654' N	9° 52,571' E	2	36	70
P413/14-4	GC6L	16.05.11	10:08	43° 56,648' N	9° 52,577' E	2	37	423
P413/15-1	GC12L	16.05.11	13:42	43° 49,236' N	9° 35, 013' E	2	426	635
P413/15-2	MUC	16.05.11	14:48	43° 49,247' N	9° 35, 020' E	2	431	43
P413/15-3	CTD	16.05.11	15:49	43° 49,5709' N	9° 36,0810' E	2	418	-
P413/15-4	MN	16.05.11	16:35	43° 49,57' N	9° 36,08' E	2	415	-
P413/16-1	FC	17.05.11	04:33	43° 56,029' N	9° 51,094' E	2	59	-
P413/16-2	FC	17.05.11	04:39	43° 56,033' N	9° 51,085' E	2	59	-

P413/16-3	FC	17.05.11	04:55	43° 56,032' N	9° 51,091' E	2	58	20
P413/16-4	GC3	17.05.11	05:04	43° 56,032' N	9° 51,091' E	2	61	-
P413/17-1	GC3	17.05.11	06:20	43° 55,425' N	9° 49,658' E	2	81	-
P413/17-2	GC9	17.05.11	07:30	43° 55,436' N	9° 49,648' E	2	81	491
P413/18-1	FC	17.05.11	08:30	43° 54,442' N	9° 47,315' E	2	116	70
P413/18-2	GC9	17.05.11	08:41	43° 54,436' N	9° 47,309' E	2	116	405
P413/19-1	GC12	17.05.11	12:11	43° 2,629' N	9° 16,112' E	2	662	687
P413/19-2	MUC	17.05.11	13:21	43° 2,628' N	9° 16,117' E	2	657	-
P413/19-3	MUC	17.05.11	?	43° 2,630' N	9° 16,122' E	2	657	39
P413/19-4a	MN	17.05.11	15:03	43° 2,51' N	9° 15,99' E	2	661	-
P413/19-4b	MN	17.05.11	15:47	43° 2,52' N	9° 16,02' E	2	663	-
P413/20-1	FC	18.05.11	06:20	44° 16,000' N	9° 14,354' E	3	113	70
P413/20-2	FC	18.05.11	06:33	44° 16,003' N	9° 14,346' E	3	113	70
P413/20-3	GC6	18.05.11	06:46	44° 16,003' N	9° 14,339' E	3	113	250
P413/20-4	GC6	18.05.11	07:15	44° 16,002' N	9° 14,330' E	3	113	301
P413/21-1	FC	18.05.11	08:07	44° 17,573' N	9° 16,202' E	3	69	25
P413/21-2	FC	18.05.11	08:18	44° 17,573' N	9° 16,207' E	3	69	20
P413/21-3	FC	18.05.11	08:26	44° 17,573' N	9° 16,189' E	3	69	25
P413/21-4	GC6	18.05.11	08:36	44° 17,563' N	9° 16,200' E	3	69	400
P413/21-5	GC9	18.05.11	09:17	44° 17,577' N	9° 16,201' E	3	70	516
P413/22-1	FC	18.05.11	10:07	44° 18,084' N	9° 16,799' E	3	52	30
P413/22-2	FC	18.05.11	10:16	44° 18,086' N	9° 16,802' E	3	51	55
P413/22-3	FC	18.05.11	10:28	44° 18,081' N	9° 16,797' E	3	51	35
P413/22-4	GC9	18.05.11	10:55	44° 18,088' N	9° 16,798' E	3	51	486
P413/23-1	FC	18.05.11	12:00	44° 18,585' N	9° 17,406' E	3	26	25
P413/23-2	FC	18.05.11	12:05	44° 18,585' N	9° 17,406' E	3	26	25
P413/23-3	FC	18.05.11	12:11	44° 18,588' N	9° 17,404' E	3	26	25
P413/23-4	FC	18.05.11	12:16	44° 18,587' N	9° 17,403' E	3	26	20
P413/23-5	FC	18.05.11	12:27	44° 18,585' N	9° 17,405' E	3	26	10
P413/23-6	FC	18.05.11	12:38	44° 18,590' N	9° 17,409' E	3	25	-

P413/23-7	FC	18.05.11	12:46	44° 18,588' N	9° 17,409' E	3	26	10
P413/23-8	GC6	18.05.11	12:52	44° 18,588' N	9° 17,410' E	3	25	430
P413/24-1	GC12	18.05.11	14:43	44° 11,061' N	9° 8,730' E	3	853	808
P413/24-2	CTD	18.05.11	16:38	44° 11,0641' N	9° 08,7480' E	3	868	-
P413/24-3	MUC	18.05.11	17:28	44° 11,063' N	9° 8,739' E	3	852	41
P413/24-4a	MN	18.05.11	18:15	44° 10,92' N	9° 8,47' E	3	863	-
P413/24-4b	MN	18.05.11	19:08	44° 10,95' N	9° 8,52' E	3	859	-
P413/25-1	FC	19.05.11	04:30	44° 17,670' N	9° 5,880' E	3	115	40
P413/25-2	GC3	19.05.11	04:51	44° 17,687' N	9° 5,867' E	3	115	250
P413/25-3	GC6	19.05.11	05:23	44° 17,683' N	9° 5,856' E	3	115	523
P413/26-1	FC	19.05.11	05:56	44° 18,440' N	9° 6,137' E	3	103	40
P413/26-2	GC9L	19.05.11	06:45	44° 18,442' N	9° 6,139' E	3	103	240
P413/27-1	FC	19.05.11	07:24	44° 19,726' N	9° 6,629' E	3	77	35
P413/27-2	FC	19:05.11	07:34	44° 19,731' N	9° 6,637' E	3	77	25
P413/27-3	FC	19.05.11	07:42	44° 19,726' N	9° 6,625' E	3	77	40
P413/27-4	GC	19.05.11	07:51	44° 19, 726' N	9° 6,624' E	3	77	403
P413/28-1	GC12L	19.05.11	09:00	44° 15,799' N	9° 2,188' E	3	465	-
P413/28-2	GC12L	19.05.11	10:02	44° 15,775' N	9° 2,182' E	3	462	712
P413/29-1	FC	20.05.11	06:18	44° 21,097' N	8° 53,501' E	3	106	60
P413/29-2	FC	20.05.11	06:30	44°21,089' N	8° 53,497' E	3	106	60
P413/29-3	GC3S	20.05.11	06:42	44° 21,087' N	8° 53,497' E	3	106	300
P413/29-4	GC6L	20.05.11	07:30	44° 21,094' N	8° 53,496' E	3	106	406
P413/30-1	FC	20.05.11	08:27	44° 23,254' N	8° 54,418' E	3	51	30
P413/30-2	FC	20.05.11	08:38	44° 23,265' N?	8° 54,399' E	3	51	55
P413/30-3	FC	20.05.11	08:46	44° 23,56' N	8° 54,399' E	3	51	55
P413/30-4	FC	20.05.11	08:56	44° 23,257' N	8° 54,403' E	3	51	55
P413/30-5	GC12L	20.05.11	09:03	44° 23,255' N	8° 54,407' E	3	51	355
P413/31-1	FC	20.05.11	10:09	44° 23,668' N	8° 51,812' E	3	49	-
P413/31-2	FC	20.05.11	10:15	44° 23,671' N	8° 51,806' E	3	49	-

P413/31-3	FC	20.05.11	10:20	44° 23,664' N	8° 51,807' E	3	49	1
P413/32-1	FC	20.05.11	10:56	44° 22,257' N	8° 51,979' E	3	94	60
P413/33-1	FC	20.05.11	11:59	44° 23,692' N	8° 46,091' E	3	68	-
P413/33-2	FC	20.05.11	12:05	44° 23,692' N	8° 46,101' E	3	68	50
P413/33-3	FC	20.05.11	12:13	44° 23,694' N	8° 46,106' E	3	68	50
P413/33-4	FC	20.05.11	12:20	44° 23,698' N	8° 46,084' E	3	68	50
P413/33-5	FC	20.05.11	12:28	44° 23,697' N	8° 46,078' E	3	68	50
P413/33-6	GC12L	20.05.11	12:38	44° 23,699' N	8° 46,078' E	3	68	412
P413/34-1	FC	20.05.11	13:27	44° 22,243' N	8° 44,360' E	3	88	60
P413/34-2	FC	20.05.11	13:40	44° 22,254' N	8° 44,361' E	3	88	60
P413/34-3	GC6	20.05.11	13:52	44° 22,249' N	8° 44,367' E	3	88	196
P413/35-1	GC12L	20.05.11	14:56	44° 19,375' N	8° 40,959' E	3	196	719
P413/35-2	FC	20.05.11	15:13	44° 19,382' N	8° 40,959' E	3	196	60
P413/35-3	FC	20.05.11	15:29	44° 19,383' N	8° 40,959' E	3	196	60
P413/35-4	FC	20.05.11	15:43	44° 19,35' N	8° 40,95' E	3	195	60
P413/36-1	FC	21.05.11	04:36	44° 22,845' N	8° 54,245' E	3	67	30
P413/36-2	FC	21.05.11	04:46	44° 22,833' N	8° 54,243' E	3	68	30
P413/36-3	FC	21.05.11	04:56	44° 22,835' N	8° 54,245' E	3	68	-
P413/36-4	FC	21.05.11	05:01	44° 22,839' N	8° 54,250' E	3	68	75
P413/36-5	FC	21.05.11	05:10	44° 22,841' N	8° 54,251' E	3	67	75
P413/36-6	FC	21.05.11	05:17	44° 22,843' N	8° 54,241' E	3	67	-
P413/36-7	GC9L	21.05.11	05:29	44° 22,844' N	8° 54,234' E	3	67	-
P413/37-1	GC12L	21.05.11	08:45	44° 14,480' N	8° 51,511' E	3	728.5	773
P413/37-2	CTD	21.05.11	09:32	44° 14,5561' N	8° 51,2050' E	3	733	-
P413/37-3a	MN	21.05.11	10:18	44° 14,496' N	8° 51,204' E	3	727.8	-
P413/37-3b	MN	21.05.11	10:40	44° 14,496' N	8° 51,204' E	3	727.8	-
P413/37-4	MUC	21.05.11	11:25	44° 14,506' N	8° 51,210' E	3	735.3	42
P413/38-1	MUC	21.05.11	14:26	43° 58,665' N	8° 40,427' E	3	1700	35
P413/38-2	GC12	21.05.11	16:00	43° 58,662' N	8° 40,36' E	3	1697	640

P413/39-1	FC	22.05.11	06:44	43° 45,273' N	7° 35,681' E	4	71.3	60
P413/39-2	FC	22.05.11	06:53	43° 45,290' N	7° 35,696' E	4	71	60
P413/39-3	FC	22.05.11	07:01	43° 45,289' N	7° 35,709' E	4	71	60
P413/39-4	GC3	22.05.11	07:11	43° 45,289' N	7° 35,704' E	4	72	250
P413/39-5	GC3	22.05.11	07:24	43° 45,272' N	7° 35,681' E	4	71	267
P413/40-1	FC	22.05.11	08:12	43° 45,684' N	7° 35,352' E	4	62	50
P413/40-2	FC	22.05.11	08:21	43° 45,685' N	7° 35,358' E	4	62	50
P413/40-3	GC6	22.05.11	08:32	43° 45,687' N	7° 35,361' E	4	62	445
P413/41-1	FC	22.05.11	08:55	43° 46,025' N	7° 35,163' E	4	51	-
P413/41-2	FC	22.05.11	09:00	43° 46,026' N	7° 35,174' E	4	51	25
P413/41-3	FC	22.05.11	09:09	43° 46,019' N	7° 35,176' E	4	51	30
P413/41-4	FC	22.05.11	09:17	43° 46,019' N	7° 35,181' E	4	51	25
P413/41-5	GC9	22.05.11	09:26	43° 46,02' N	7° 35,18' E	4	51	492
P413/42-1	FC	22.05.11	10:17	43° 46,175' N	7° 35,241' E	4	47	60
P413/42-2	FC	22.05.11	10:25	43° 46,167' N	7° 35,245' E	4	47	60
P413/42-3	FC	22.05.11	10:32	43° 46,173' N	7° 35,238' E	4	47	60
P413/42-4	GC9	22.05.11	12:54	43° 46,165' N	7° 35,225' E	4	47	516
P413/43-1	FC	23.05.11	06:07	43° 45,735' N	7° 39,346' E	4	92	40
P413/43-2	FC	23.05.11	06:20	43° 45,734' N	7° 39,333' E	4	92	40
P413/43-3	FC	23.05.11	06:26	43° 45,742' N	7° 39,339' E	4	92	40
P413/44-1	FC	23.05.11	07:43	43° 46,963' N	7° 42,788' E	4	63	20
P413/44-2	FC	23.05.11	07:52	43° 47,002' N	7° 42,798' E	4	63	25
P413/44-3	FC	23.05.11	08:00	43° 46,992' N	7° 42,775' E	4	62	25
P413/44-4	GC6	23.05.11	08:09	43° 46,975' N	7° 42,775' E	4	64	400
P413/44-5	GC6	23.05.11	08:34	43° 46,963' N	7° 42,787' E	4	65	422
P413/45-1	FC	23.05.11	09:52	43° 44,232' N	7° 44,592' E	4	284	60
P413/45-2	FC	23.05.11	10:10	43° 44,243' N	7° 44,585' E	4	284	70
P413/45-3	FC	23.05.11	10:26	43° 44,239' N	7° 44,399' E	4	284	70
P413/45-4	GC6	23.05.11	10:44	43° 44,240' N	7° 44,598' E	4	282	514
P413/46-1	GC12	23.05.11	13:29	43° 31,534' N	7° 43,387' E	4	2199	665

P413/46-2a	MN	23.05.11	15:04	43° 31,71' N	7° 43,61' E	4	2195	-
P413/46-2b	MN	23.05.11	15:20	43°31.69' N	07°43.61' E	4	2196	-
P413/46-3	MUC	23.05.11	16:07	43° 31,701	7° 43,595' E	4	2194	29
P413/46-4	CTD	23.05.11	17:55	43° 31,8890' N	7° 43,7010' E	4	2210	-
P413/47-1	FC	24.05.11	06:23	43° 49,464' N	7° 52,338' E	4	30	65
P413/47-2	FC	24.05.11	06:29	43° 49,466' N	7° 52,342' E	4	30	65
P413/47-3	FC	24.05.11	06:34	43° 49,460' N	7° 52,342' E	4	30	65
P413/48-1	FC	24.05.11	07:11	43° 49,119' N	7° 52,350' E	4	56	50
P413/48-2	FC	24.05.11	07:18	43° 49,121' N	7° 52,354' E	4	56	50
P413/48-3	FC	24.05.11	07:24	43° 49,122' N	7° 52,340' E	4	57	50
P413/48-4	GC6	24.05.11	07:33	43° 49,12' N	7° 52,33' E	4	57	450
P413/48-5	GC6	24.05.11	07:55	43° 49,125' N	7° 52,331' E	4	57	453
P413/49-1	FC	24.05.11	09:03	43° 48,619' N	7° 52,433' E	4	93	60
P413/49-2	FC	24.05.11	09:11	43° 48,629' N	7° 52,419' E	4	93	60
P413/49-3	FC	24.05.11	09:20	43° 48,632' N	7° 52,421' E	4	93	60
P413/49-4	GC6	24.05.11	10:04	43° 48,629' N	7° 52,421' E	4	93	368
P413/50-1	FC	24.05.11	10:43	43° 47,757' N	7° 50,449' E	4	89	60
P413/51-1	FC	24.05.11	11:19	43° 46,927' N	7° 48,792' E	4	88	40
P413/51-2	GC6	24.05.11	11:28	43° 46,924' N	7° 48,777' E	4	87	135
P413/52-1	GC6	24.05.11	12:16	43° 45,017' N	7° 49,927' E	4	374	387
P413/53-1	GC12	24.05.11	14:20	43° 32,81' N	7° 41,53' E	4	2201	716
P413/54-1	FC	25.05.11	04:01	43° 52,050' N	8° 3,640' E	4	49	35
P413/54-2	FC	25.05.11	04:09	43° 52,052' N	8° 3,644' E	4	49	-
P413/54-3	FC	25.05.11	04:14	43° 52,051' N	8° 3,652' E	4	49	-
P413/54-4	FC	25.05.11	04:21	43° 52,044' N	8° 3,652' E	4	49	35
P413/54-5	FC	25.05.11	04:28	43° 52,046' N	8° 3,651' E	4	49	30
P413/55-1	FC	25.05.11	05:23	43° 53,656' N	8° 5,507' E	4	34.9	-
P413/55-2	FC	25.05.11	05:26	43° 53,655' N	8° 5,505' E	4	34.8	-
P413/55-3	FC	25.05.11	05:31	43° 53,656' N	8° 5,503' E	4	34.8	10

P413/55-4	FC	25.05.11	05:37	43° 53,654' N	8° 5,500' E	4	34.8	-
P413/55-5	FC	25.05.11	05:40	43° 53,653' N	8° 5,497' E	4	34.8	-
P413/55-6	GC3	25.05.11	06:01	43° 53,657' N	8° 5,500' E	4	34.3	-
P413/55-7	GC3	25.05.11	06:18	43° 53,660' N	8° 5,507' E	4	35	100
P413/56-1	FC	25.05.11	07:10	43° 54,489' N	8° 8,118' E	4	48	-
P413/56-2	FC	25.05.11	07:10	43° 54,480' N	8° 8,101' E	4	48	-
P413/56-3	FC	25.05.11	07:20	43° 54,477' N	8° 8,103' E	4	48	-
P413/57-1	FC	25.05.11	07:58	43° 55,956' N	8° 9,221' E	4	37	-
P413/57-2	FC	25.05.11	08:01	43° 55,956' N	8° 9,226' E	4	37	10
P413/57-3	FC	25.05.11	08:08	43° 55,955' N	8° 9,220' E	4	37	10
P413/57-4	GC3	25.05.11	08:16	43° 55,955' N	8° 9,220' E	4	37	231
P413/58-1	GC6	25.05.11	10:02	43° 51,365' N	8° 13,476' E	4	510	500
P413/58-2	GC12	25.05.11	10:58	43° 51,373' N	8° 13,477' E	4	510	530
P413/58-3	MUC	25.05.11	12:01	43° 51,363' N	8° 13,476' E	4	510	40
P413/59-1	CTD	25.05.11	14:16	43° 49,1000' N	8° 28,8020' E	4	2335	-
P413/59-2a	MN	25.05.11	16:00	43° 49,103' N	8° 28,814' E	4	2282	-
P413/59-2b	MN	25.05.11	16:00	43° 49,103' N	8° 28,814' E	4	2282	-
P413/60-1	MUC	26.05.11	06:00	43° 32,718' N	8° 50,271' E	2	2240	28
P413/60-2	GC12	26.05.11	07:52	43° 32,72' N	8° 50,27' E	2	2240	609
P413/61-1	GC12	26.05.11	10:50	43° 39,747' N	9° 1,913' E	2	2002	429

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